SCIENTIFIC AMERICAN
No. SUPPLEMENT, 255

Scientific American Supplement, Vol. X., No. 255.
Scientific American, established 1845.

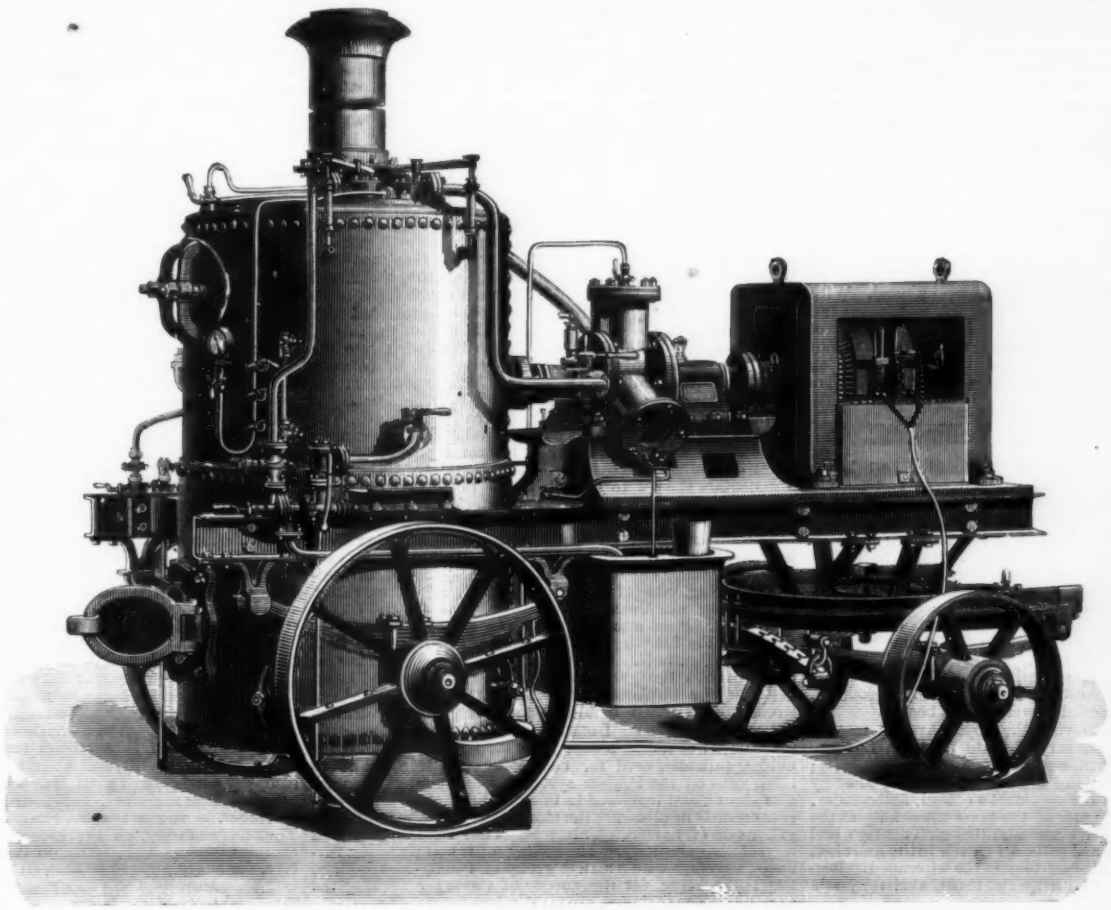
NEW YORK, NOVEMBER 20, 1880.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

MILITARY STEAM ELECTRIC MACHINE AND LIGHT.

An old proverb says that necessity is the mother of invention. In the history of the human race there has existed scarcely any necessity more pressing than that of providing means of defense against the enemy. Under the pressure of such a necessity, numerous industries have from time to time sprung up and contributed to perfect what, by an abuse of words, is styled the art of war; and none of the forces that man is able to produce or govern have been neglected in the gradual development of this art. Nor, in recent years, has electricity been overlooked. It is a powerful as well as a tractable agent, and one from which numerous advantages are to be derived; in fact, one could scarcely imagine the number of uses to which it has already been put in the military art. In naval affairs, for instance, it has been used to put the vessel more and more completely under the control of the commanding officer. For this purpose the telegraph has been applied for the transmission of orders, especially to the engineer. In this case the captain has at hand a dial provided with all the necessary signals, and over the face of which moves an index needle. By placing the latter over the order that he wishes to communicate, a similar index simultaneously reproduces this movement on a dial located in the engine room. Counters of revolutions have also been devised for indicating to the captain at any moment the velocity of the screw. By means of these he is enabled to know the progress that is being made by his vessel, and to see at once that his orders are being executed. In some of these apparatus electricity is not employed, but others are based entirely on its use.

Commander Trève some years ago proposed to go still further, and by the use of an electric apparatus (which was quite complex, however), to permit the captain to manage the engine himself. Here all orders would be done away with; the commander at his post starting, slowing, and stopping the vessel at will by means of contacts. This apparatus seems never to have been actually applied. The same officer has also proposed an apparatus by means of which the captain can steer his own ship. As well known, the movements of the rudder in large ships are now no longer effected by hand, but by the action of a small special steam engine, which serves equally for raising anchors, rotating armor-plated turrets, and, in fact, for all operations requiring great power. For steering, it is only necessary, then, to provide this engine with the proper gearings. M. Achard had proposed a system of this kind at about the same time as Commander Trève; and M. Caselli has combined one which is now being tried on a vessel belonging to the Italian navy.



MILITARY STEAM ELECTRIC MACHINE AND LIGHT.

Serious experiments have also been made in firing artillery by electricity, in order to obtain as great accuracy as possible in the projection of the shot—something very necessary at sea. To reach such a result, primers and quick-matches of a special nature were combined. Ignition was effected originally by Planté's secondary piles, which were in charge of the gunners, and which received their electric charge from a Leclanché battery. More recently, Leclanché piles of four elements of large surface have simply been used. By this system the firing of a whole battery is absolutely simultaneous; indeed, the captain may fire it himself if he chooses. Under such conditions a ship of war is no longer distinguished by its chief; it is an enormous cuirass—a formidable one-man power, and absolutely justifies the term *man of war*. This extreme centralization seems to be diametrically opposite the course now followed in army matters. In view of the formidable weapons that we at present possess, the surface of the combatant is diminished as much as possible, and it is desirable that he should be very quick, very light, and very independent. In the navy, on the contrary, we set up enormous and massive structures in which are collected together colossal engines of war; and we risk this entire and excessively costly affair, freighted with human lives, to the chances of being destroyed by a single well directed shot. This is still the more singular in face of the new and formidable means of attack that electricity has furnished in the use of torpedoes of all kinds. The only efficacious means of defense that have been found against these, in fact, is to see them in time; and here again electricity plays a first-class *rôle* in furnishing the powerful light which permits of illuminating the far off space and discovering the assailant. The latter application of electricity, moreover, is common in both the army and

navy, and is every day assuming more importance, and becoming the object of much study. The first experiments were made as long ago as 1855, on the Jerome Napoleon, with Alliance magneto-electric machines and a light-projector. In those times it was not a question of seeing, but rather of being seen, and electricity was employed as a ship's light of great power. The results, although they gave great hopes, were not completely satisfying, and the question was gradually abandoned. Not far from this epoch, in 1859, the electric light was tried in the Italian war; but electric piles were employed, and it is useless to say that the idea was not practicable and had no immediate results.

The question was taken up again at the siege of Paris in 1870; but the results were unimportant, the light not having sufficient range to show the distant German batteries. Messrs. Sautter & Lemonnier, in France, afterward took the subject in hand and obtained a most satisfactory solution of the problem by the aid of the Gramme machine. We represent herewith the apparatus as they have arranged them for purposes of war, *i. e.*, mounted on wagons in such a way as to render them easily transportable. In the navy, of course, they have a fixed place on board the vessel. The reflector is composed of a tube in which is inserted a Fresnel lens, at the focus of which is a Serrin regulator. The generator of electricity is a Gramme machine put in motion by a steam motor of the Brotherwood system; rotation being effected directly and without the use of belts. The whole apparatus is easily manageable and very solid. Several interesting applications that have been made have shown the value of the system. Nevertheless, it has been further perfected by the use of a reflector due to Colonel Mangin. This gentleman employs a concave glass mirror, the two surfaces of which are of unequal radius—the front one, which is transparent, serving to correct spherical aberration, and the back one being a reflector. Combining this apparatus with the Gramme machine, before described, a remarkably powerful light projector is obtained. Messrs. Sautter & Lemonnier, the makers of the apparatus, have introduced all the elements of success which their experience has furnished. They have so inclined the carbons as to give the most light possible,* and have reduced the lamp to its simplest expression—to two carbons moved by hand. With these apparatus it has been found practicable to discover and follow the movements of small ships at sea at a distance of two miles, and on land to see edifices at a distance of about six miles. These, or analogous apparatus, were in use on the shores of the Black Sea during the whole Turco-Russian war.

THE ROYAL ARSENAL, WOOLWICH.

THE above establishment is the great national workshop in which all the war *materiel* of Great Britain and her numerous colonies is manufactured. It has been a source of interest to, and has been visited by, nearly every monarch of Europe who has reigned during the last two hundred years. The oldest map of the Arsenal extant bears date 1701; but the establishment existed as far back as 1490. At the present time it covers 333 acres of land, without including the large tract occupied by the powder magazines in the adjacent marshes. Considering the important connections and events of which the Arsenal at Woolwich has been the theater, it deserves the first place in engineering history. It possesses characteristics peculiarly its own, and presents sights of which neither Greece, with her immense resources, nor Rome, with her imperial powers, could boast.

Application for cards to visit the Royal Arsenal may be made by post to the Secretary of State for War, London. If the applicant be a British subject there is no difficulty; but if a foreigner, the application has to be accompanied by a recommendation from the applicant's consul, ambassador, or some responsible foreigner of the same nationality as the applicant. English visitors are admitted on Tuesdays and Thursdays, between ten and half-past eleven in the morning, and between two and half-past four in the afternoon. Foreign visitors are supplied with special cards, available, as a rule, at any time.

The main entrance gates were erected by Messrs. Hill & Sons, of Dartford, in 1829. Two other gates exist to the east of the main entrance, and are used only by the employes. In time of peace the workmen number 10,000, and in times of war the number often reaches 15,000. On the green opposite the entrance gates is a large gun, twenty feet in length, of French manufacture, dated 1607, which was brought from Malta. It is composed of one hundred parts copper and eleven tin, and is mounted on a carriage made in the Arsenal in 1827, when the late Duke of Wellington was Master-General of Ordnance. The gun carriage is embellished with figures of various animals, and the shield on the off-side of the gun bears the motto, "*La foy Citta Victoriosa.*" Leaving this gun on the right, we come to the offices of the Committee of Inventions, who carry out the various gun trials and other experiments made in the Arsenal. Contiguous to these offices is a suite of rooms, through whose portals visitors never enter, containing the newest improvements in modern ordnance.

The brass gun foundry, near the entrance gates, is one of the oldest buildings in the Arsenal, and somewhat resembles a church, with gun-shaped chimneys. Near the center of the foundry is a bricked archway bearing the names of the most renowned master founders, such as Schalch, Verbruggen, King, North, Eccles, etc. Brass and bronze guns are now superseded by wrought iron guns, and nothing is done here in gun-casting; but the foundry still possesses all the appliances for manufacturing those once formidable weapons.

The dial square, which takes its name from a venerable sundial which adorns the gateway bearing date 1764, has a citadel-like appearance, with huge brick buttresses, and presents altogether rather a formidable aspect. This imposing building is seldom inspected by visitors; but the engineer or man of science would find in it much to interest him. In a large workshop, known as the turnery, may be found the largest machines in the world, including a planing machine capable of giving a true surface to iron plates six feet wide and thirty feet long; also a lathe having a face plate nine feet in diameter, which will turn a mass of iron of almost any weight. In this building will also be found an endless variety of other important machinery, which would require the descriptive genius of a George Robins to do justice to. Lying about the place are numerous armor plates, which have been tested with various sized guns for the purpose of ascertaining their resisting power. Around here are also scattered, in a place called the "cemetery," the fragments of all kinds of guns which have been tested to destruction, or otherwise have broken down under trial. These dead guns bear epitaphs, giving their history and the number of rounds endured before they perished. In the neighborhood of this square is a large iron foundry, in which, a few years ago, a mass of iron was cast for the bed of an anvil block weighing seventy tons, which was afterwards placed under one of the Nasmyth steam hammers.

* As well known, the maximum ray is not in the plane perpendicular to the line of the carbons; as a result of the studies of these gentlemen, it is found to be about 30° above this plane.

NINE-MILE GUNS.

In the Royal Gun Factories the new forge or coiling mills form the first object of interest. Here is performed the first operation in the manufacture of modern guns. The iron bars forming the coil vary from 12 feet to 420 feet in length. They are heated in furnaces almost to a white heat, the temperature of the bar being regulated with extreme nicety, so as to insure the requisite flexibility and elasticity. At the mouth of the furnace is a revolving core and mandrel which draws the heated bars and winds them round rollers, apparently as easily as a person can wind a piece of string round his finger. The door of the furnace weighs eight tons, and the doorway is sufficiently large to admit an omnibus. The steam hammer, used in the forging of heavy gunnery, contains 2,000 tons of solid metal, and comes down with a force of 1,000 tons. The Nasmyth hammers can be worked with such nice perfection as to touch the glass of a gold watch without breaking it, and will crack a nut without injuring the kernel. To witness the coiling of a gun requires some nerve. The furnace is a burning fiery cave, from which many a mighty monarch has shrunk back. Near the coiling furnace stands a shearing machine which will sever a bar of iron seven inches thick with as little effort as if it were a bar of soap. The new forge also contains boring, punching, cutting, slotting, and other machines, which, with the clanking of small hammers, the thunder of larger ones, the clatter of machinery, the creaking of furnace doors, and other unearthly noises, make the visitor regard it as a vast scene of confusion; but it is, nevertheless, an admirably arranged system of the most perfect order. The Woolwich guns coiled here cost when finished £70 per ton. They have endured upwards of 2,000 rounds with extraordinary charges. The largest gun which has been manufactured at the Royal Arsenal is the eighty-one ton, which will throw a shot of more than half a ton with such force as to penetrate, at 1,000 yards distant, an ironclad protected with twenty-seven inches of solid armor. It is also capable of sending a projectile of 1,800 lb. from Woolwich into the city of London—a distance (as the crow flies) of between eight and nine miles. The English War Department has four one-hundred ton guns, made by Sir William Armstrong at his factory at Elswick, near Newcastle-on-Tyne. The efficiency of these guns has been proved at the Government Butts at the Arsenal, and they will form a part of the defense of Malta and Gibraltar. The Royal Gun Factories also contain the old forge, filled with ponderous hammers for welding the coils together, and attaching the trunnion hoops.

The Boring Mills form a fine specimen of ornamental brickwork, and contain some of the finest machines ever witnessed under one roof. The machines consist of horizontal boring, vertical boring, and drilling apparatus, rifling and lapping machines, turning lathes, and powerful traveling cranes. Such attention is paid to gauging the various parts that the 1,000th part of an inch is considered an item of great magnitude. The micrometer, or gauging instrument, enables the guns to be made, externally and internally, precise duplicates of each other. The turnery—a handsomely fronted building—contains powerful turning-lathes, which slice off from the solid iron beautiful ringlets, sometimes five inches broad. The turnery also contains the uniting furnaces, used for converting cast iron guns into rifled guns on the Palliser system. The smaller guns are also shrunk and tempered in this building. The latter process consists in plunging the steel tubes into a bath of 2,000 gallons of oil to cool. This renders the steel tougher and increases its elasticity. The rolling mills and puddling furnaces, together with a stately group of twenty-four boilers, the latter being for the supply of steam for working the surrounding machinery, are all admirably arranged.

The Royal Carriage Department.—The timber field comprises several acres of ground, and is used for stacking logs of wood. It is furnished with powerful traveling cranes, which pick up and transport to any desired spot logs of timber weighing ten tons with as much ease as a spectator picks up his walking-stick. Adjacent to the timber field is a canal from the Thames. On the banks of the canal are large cranes for unloading the vessels of their freights of timber, which arrive from all parts of the world. The wood mostly employed in the manufacture of war material for home service is English-grown oak, ash, and elm. Oak is used where strength and durability are desiderata, such as in traveling carriages, block trails, brackets for garrison and siege carriages, frames, heavy wagons, carts, axle-tree beds, etc. Ash is used where toughness is required, such as in framings for limbers, ammunition wagons, store carts, handspikes, rammers, lance poles, and shafts. Elm is used where powerful concussions are expected, as in ship and steamboat carriages, trucks, quoins, stole beds, and compressers. The foreign timbers employed comprise deal, pine, teak, mahogony, African oak, sabacu, peduke, and lignum vitæ. Deal and pine are used for paneling and lining moulds, bottom and roof boards, etc. Teak (which is the oak of India) is durable and handsome, and shrinks less in seasoning than any other wood. It is used for platform sides, garrison carriages, articles exposed to weather, and those for foreign service. Spanish mahogany, which is a tough, durable, hard wood, is used for carriage brackets where strength and durability are required. African oak is hard and heavy, and moderately durable, if kept dry; it is used for slides for ships and garrison purposes, and sometimes for heavy framing and trails. Sabacu, like African oak, is heavy, hard, and tough, and answers admirably for blocks where heavy weight and pressure have to be resisted. Peduke is used for foreign service in the same way as English ash is used for home service. Lignum vitæ is the hardest and heaviest of all woods, and is only used for roller and handspikes. The great difficulty of getting properly seasoned timber has led to gun carriages being chiefly made of iron; wood being used for artillery wagons, military carts, ammunition boxes, ground platforms, and repairs.

The saw mills are conveniently contiguous to the timber field. During war time £1,000 worth of timber is often cut up daily. Connected with the mills are several acres of storerooms filled with ventilators, to allow the air to pass freely through the timber which is housed and seasoned here. Timber, when used damp, decays, or is subject to dry rot, and to prevent this the drying must be gradual. If rapid it loses its toughness and pliability, and the pores near the surface contract and prevent the interior moisture getting out. Timber, when well seasoned, loses two-fifths of its weight. The logs to be cut are lifted into position by a powerful hydraulic crane, and a capstan draws it to a large circular cross-cut saw, which rises through an opening in the floor, cuts off the rough end, and sinks out of sight again. This saw measures seven feet in diameter, and can be inspected by descending a flight of steps at the side. Two frames, worked vertically and fitted with a number of saws, according to the thickness and number of planks required, receive the logs from the cross-cut saw. Among the machinery about here is a planing machine, the bed of which can be moved at ten different speeds, the highest being 700 revolutions per minute. The cutting-wheel of this machine is upward of four feet in diameter, and the bed twenty feet in length. The latter are worked backward and forward by a traction disk. There are several machines deserving especial attention, including one for shaping shafts, which gives the wood the required curve and longitudinal section with wonderful accuracy.

The steam wheel factory is the most perfect establishment of its kind in the world. The rough timber enters at one door and goes out at the other a perfect wheel. The copying lathes, designed by Blanchard (an American), enable anything in wood to be copied with perfect truth. They are used for making spokes, rammers, sponge blocks, handspikes, lifting-jack stands, lance poles, prop sticks, etc. The spokes are squeezed into the wheels by a hydraulic ram exerting a pressure of 240 tons. The hoops and tires are shrunk on in the shoeing pit. The endless saw and oscillating table, for giving timber any required shape, and a special machine for moulding the edges of fellies, are worth seeing.

The painters' shop, constructed of iron and glass, is 285 feet long and proportional width, and was built in 1854. Here is accommodation for eighty painters. As nearly everything in the service is lettered and numbered, several men and lads are kept occupied in "writing," military wheelers being also taught writing and mixing colors, to enable them to perform this work when at foreign stations. Four hundredweight of lead color is ground daily in the paint mill, thus obviating the laborious and unwholesome operation of grinding it with a stone and muller.

The collar makers' shop is a continuous gallery 140 feet long. Here men are employed at harness, saddlery, pack saddles, litters, and ambulances for conveying the wounded off the battle-field. Here also are made sponges for guns, fire engines, hose, buckets, etc.

Leaving the wood, we come to the iron department, or, as it is called, the Great Smithery. Here the main forge presents itself as the largest smiths' shop in the world. It contains sixty forges, eight steam hammers (ranging from 5 to 70 cwt.), three furnaces, a powerful punching machine by De Berge, which will cut a hole in a sheet of iron 1½ inches thick; and some of Ryder's forging machines, the largest ever made. In this shop are forged all the heavier kinds of ironwork used in the construction of gun carriages, such as angle frames for siege carriages, girders for platforms and slides, garrison carriages, etc.

The Scrap Forge.—Here the scraps or cuttings of iron are reheated and beaten into shape by large steam hammers, which renovate 1,080 tons every year, a cyclopean feat which consumes 1,800 tons of coal. By this means the refuse iron and obsolete iron articles from all parts of England and from every foreign station and colony, however uncouth and misshapen, undergo a complete transformation. In the rolling mills the iron is rolled into bars and bands.

The Main Factory contains machines of the newest and most perfect kinds for preparing, erecting, and finishing iron gun carriages. The heaviest work is done by traveling cranes capable of lifting from twelve to twenty tons, enabling one man to lift, and place in any required position, a complete carriage and platform. The other machinery comprises planing machines, radial drilling machines, slotting machines, boring machines, riveting machines, and lathes. The platform shop, on the east side of the main factory, contains huge iron platforms, in various stages of manufacture, for heavy guns to be used on board ship and at fortifications. Most of the platforms are fitted with hydraulic rams and toothed gearing to assist in working the modern heavy artillery. In the field carriage shop, at the west end of the main factory, are made iron field carriages, limbers, and ammunition wagons, which comprise the equipment of the Royal Horse Artillery and field batteries. In this shop is an endless band-saw, which will cut through iron of any thickness. In the smiths' shop is a machine called "Collier's patent nut-maker," capable of turning out 3,000 nuts per day. The holes for bolts and rivets are made by a machine punch, which can be stopped at any instant in its descent. The shears have ponderous jaws, which cut asunder large bars of iron with all the ease imaginable. The punching and cutting machines are in constant requisition in the manufacture of pontoons for cavalry, artillery, and infantry. These pontoons are cylindrical barrels, about 22 feet long by 2½ feet in diameter, with hemispherical ends, and divided into compartments, to prevent their sinking if perforated in any part. They are used in forming bridges over rivers and lakes for the conveyance of troops and their accouterments. The pattern-room of the Royal Carriage Department contains highly-finished specimens of the gun carriages and everything manufactured in that department. In busy times the Royal Carriage Department at Woolwich employs 2,400 men, and in slack times about 1,700. Their time is registered by means of tickets. Each artisan, on entering the carriage square, is provided with three tickets (bearing his registered number), which have to be deposited in the ticket boxes as follows: At 6 A.M. a zinc ticket; at 9 a brass ticket; and at 2 a copper ticket. The presence of the ticket signifies the presence of the workman whose number it bears. Time-keepers compare the entries in the foremen's books with the records of the ticket-keeper, and if any discrepancy appears, one of them instantly repairs to the shop where the man ought to be at work.

The Control Department.—The above comprises a long range of buildings extending the whole length of the western wharf. Projecting from the wharf is the T pier for shipping and unshipping military stores. This pier is associated with many events of interest, having been used as the place of arrival and departure of some of the principal crowned heads and other modern celebrities on the occasion of their visits to England. The pier is joined by a branch line, known as the Arsenal Railway, to the North Kent line. The Control Department possesses some fine hydraulic machinery and noble store-houses, from which everything required by the army can be supplied at a moment's notice. Guns, gun carriages, wagons, carts, harness, shot, shell, cartridges, tents, barrack and stable furniture, and every conceivable requisite of war, for use in the colonies and home stations, are accumulated here. The lifting power in this department of the Royal Arsenal consists of sixteen hydraulic and ten hand cranes,

the former ranging from ten to one hundred tons. A machine at the lower end of the wharf, called the shear legs, is capable of lifting a weight of sixty tons. In the harness stores there are always ready sets of harness for 10,000 horses, and 40,000 more sets could be turned out at a very short notice. On the shot ground may be viewed hundreds and thousands of shot and shell of all kinds, shapes, and sizes, piled up in huge pyramids. This department contains many interesting trophies of war. In the central avenue stands a statue of the late Duke of Wellington, which was removed from the Tower of London in 1860. The Mallet's monster mortar, also to be seen here, weighs forty-one tons, and will throw a 36-inch shell, weighing 2,548 lb., a distance of a mile and a quarter.—*Universal Engineer.*

TRIAL OF A COMPRESSED AIR LOCOMOTIVE.

A PRACTICAL experiment, which was lately tried with an air engine at Woolwich, afforded hopes that humanity and economy may be speedily promoted by the abolition of tramway horses, and that the sufferings of travelers by the underground railways may be mitigated before long by the substitution of atmospheric power for the sulphurous locomotives propelled by steam. The engine, which has been designed by Colonel Beaumont, Royal Engineers, has been for some time running on the short lines of the Royal Arsenal; and although weighing but ten tons, it has proved capable of hauling a burden of sixteen tons up a fair incline; and last month arrangements were made to try its powers in a more extended run, such as engines of the kind would have to encounter on the London rail and tramways. The air reservoir, which contains only 100 cubic feet of air, was charged at the torpedo pumping-house up to a pressure of 1,000 lb. to the square inch, and with this store of energy it was proposed to run to and from Dartford, about sixteen miles. Colonel Beaumont was accompanied on the engine by Mr. E. S Sears, assistant superintendent of the South Eastern Railway, and other gentlemen, and explained the method which he had adopted in his invention, the chief feature of which was the introduction of an almost imperceptible supply of steam, by which the air, as it is admitted to the cylinder from the reservoir, is largely heated, and thereby greatly increased in force. The engine is driven by the cylinder and a double set of machinery at one end, and, having no smoke-stack, resembles in appearance a locomotive tender rather than a locomotive. It runs on four wheels, and in size is less than that of an ordinary omnibus. It left the Royal Arsenal at Plumstead Station at 12.22 P.M., with a full charge of 1,000 lb. to the inch, passed Abbey Wood Station at 12.27, with 940 lb. on the gauge; Belvedere at 12.33, with 860 lb ; and Erith at 12.36, with 760 lb., arriving at Dartford at 12.50, with a remaining energy of 540 lb. on the square inch. Shunting about at the station reduced this pressure somewhat, and at 1.35 the return journey commenced with a store of 510 feet. Although the minimum for effective working is considered to be a pressure of 200 feet, Plumstead Station was reached again at 2.10, but the engine was nearly pumped out, having a pressure of barely 80 lb. remaining. The strange-looking engine, running without steam or any other apparent motive power, was regarded with amusing wonderment by the country people as it passed at full speed, and was naturally an object of interest at the railway stations. It was stated that another was being constructed much more powerful; capable, in fact, of traveling double the distance with a single charge. The operation of pumping in the compressed air occupies about fifteen minutes, and it is calculated that an air engine on this principle as large as the usual steam locomotive of 50 tons weight, would be considerably more powerful than any locomotive yet made. The objection to steam that it frightens horses cannot, says the London *Times*, apply to this system, as there is no escape of steam visible or audible, and the only noise to be distinguished is a rumbling sound like the rattle of street traffic. The general belief of those who witnessed the experiment was that the application of atmospheric power to the science of traveling was a thing of the near future.

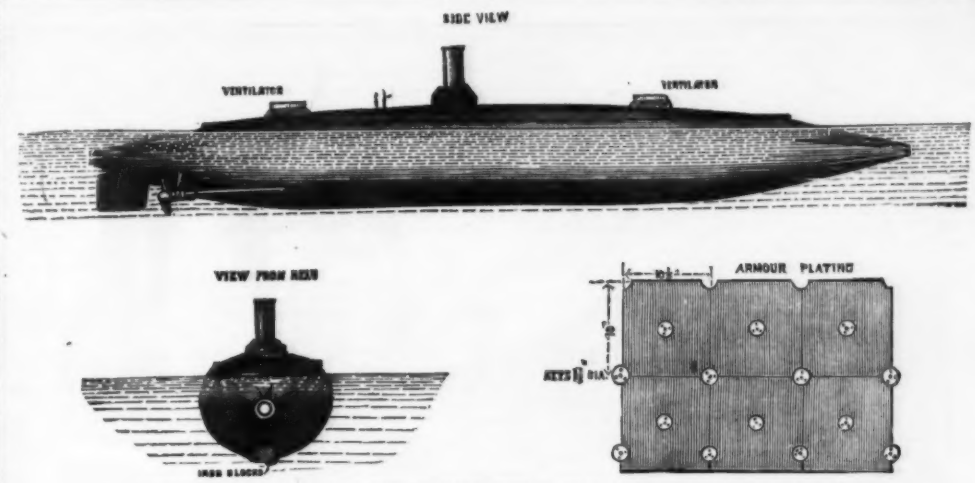
THE POLYPHEMUS.

During the recent excursion of the Society of Engineers to the Chatham dockyards, after the war ships had been inspected, the visitors were conveyed on the narrow gauge —18 inch—railway which runs through the yard to the shed wherein the Polyphemus is being built. This vessel is one of the most remarkable ever constructed, and great reticence has been observed by the Admiralty concerning her. The sketch accompanying, from the *Engineer*, will, however, serve to give a good general idea of what she is like.

The Polyphemus will not be fitted with masts or sails, but will carry a pole for signal purposes. The principal dimensions, etc., are as follows:

Length between perpendiculars.....	240 feet.
Breadth, extreme.....	40 feet.
Depth of hold.....	18 feet 9 inches.
Immersed midship section.....	625 square feet.
Mean load-draught of water.	16 feet 9 inches.
Displacement, load.	2,610 tons.
Builders of machinery, Messrs. Humphrys, Tennant & Co.	
Type of engine, compound, horizontal, single piston rod.	
Number of cylinders.....	4
Diameter of high-pressure cylinders..	38 inches.
Diameter of low-pressure cylinders..	64 inches.
Stroke of pistons, ...	39 inches.
Number of screw propellers.....	2
Total weight of machinery, including water in boilers and 10 tons of spare gear..	490 tons.
Indicated horse-power, maximum....	5,500
Speed of vessel, estimated, maximum.....	17 knots.

The engines are designed for simplicity and saving of weight. The inboard propeller shafts are hollow, of Whitworth's compressed-when-fluid steel. The surface condensers are brass. There are no expansion valves. Many parts of the engine are made of steel. The boilers are of the locomotive type, ten in number, manufactured of Landore steel, and designed to carry 120 pounds pressure on the square inch. The boilers stand athwartships, and are divided into two groups of three and two respectively, with a fore-and-aft bulkhead between them, thus making four fire-rooms in water-tight compartments. The uptakes all lead into one chimney, which is fixed. The engines each occupy the full breadth of the ship. The port engines are aft, the starboard engines forward. She is built throughout of steel,



THE NEW BRITISH TORPEDO BOAT, POLYPHEMUS.

and somewhat resembles Winan's celebrated cigar ship. The Polyphemus will carry no guns, save one or two small pieces on deck; but she will be able to launch torpedo after torpedo from the orifice—which resembles the mouth of some fishes—in the cut water, and about 8 feet below the water level. But besides this she can discharge other torpedoes at each side. She will be fitted with a ram bow or snout of formidable dimensions. She is divided into a great many compartments by suitable bulkheads, and in her hollow keel, if we may so call it, she will carry blocks of cast iron weighing 20 tons. Should she take in much water from being pierced by an enemy's shot-these blocks can be dropped into the sea at a moment's notice and the ship so far lightened. Her turtle back will be covered with scale armor secured to 2 inch plates. This scale armor consists of a series of tiles, each 10½ inches by 10 inches, by ¼ inches thick, made of Whitworth compressed steel. The tiles are secured as shown, with one screw stud at each corner, and one in the middle, the whole surface being flush; and it is anticipated that she will be impregnable to any gun which another ship of war could bring to bear upon her. She was begun just two years ago, and will be ready for launching, it is expected, next March.

MR. JAMES NASMYTH, C.E., ON FREEHAND DRAWING.

THE eminent inventor of the steam hammer writes to the London *Times* to testify to the importance of freehand drawing. Mr. Nasmyth says:

All those who take an interest in truly useful and practical education must feel obliged and thankful to Sir Henry Cole for his excellent letter in the *Times* of September 22. Sixty years' experience with engineering works, and with the mechanics and other classes of workmen engaged in such occupations, enables me to say that of the useful acquirements beyond those of "the three R's" is that of drawing. By the term "drawing" I mean the art of representing the forms of natural or artificial objects by lines, which, when even rapidly sketched by a practiced hand and educated eye, can bring an object before you with a distinctness and rapidity such as no oral or written description could accomplish. During a long and active life, engaged in occupations in which I have had daily occasion to communicate definite ideas to others in respect to forms and combination of forms, the possession to a certain extent of the power of rapidly sketching such, in order to convey correct ideas of what I desired to communicate to others, has done me more real service than any other requirement or faculty I may be in possession of. If we desire to produce really useful and effective men by means of our schools, let the pupils, by every opportunity, acquire this valuable art of hand-sketching. That is the kind of drawing which of all others will best serve the general affairs of life; and, without any attempt at producing artists as such, if our schools would confine their efforts in this direction to the simple exercise of the hand and eye, and thus enable the pupils, with pencil or chalk, to represent the object they desire to bring before you, the possession of this power will be found to transcend in its general usefulness all "tongue acquirements," and do more to lead to success and employment than any other attainment I know of. Nothing but a most earnest feeling of the practical importance of this subject would have caused me to venture to place it before your attention.

CHROME LEATHER.

THE art of tanning has, in one sense of the term, undergone a very little alteration for at least a couple of centuries. It is true that oak bark has been, to a greater or less extent, superseded by divi-divi, myrobalans, and other vegetable principles richer in tannin. It is true also that by the use of more concentrated solutions, and by a number of mechanical devices and appliances, the conversion of raw hides into leather has been greatly accelerated, now always with advantage, if we approach the question from the consumer's point of view. It is said, and not without a certain foundation of truth, that tanning, as practiced in the days of our great-grandfathers, if slow was sure. The hide was acted upon through and through by the tan liquors, and was thoroughly converted into leather in its entire thickness. With the improved processes of our own days the case is somewhat different. The outer layers of the hide are tanned, but between them lies a layer almost in its original raw condition, so that the durability of the product is highly questionable, as the consumer finds to his cost.

Quite lately, however, invention has struck out in a totally new direction, and leather has been produced, not merely without oak bark, but without any of the other astringent bodies which are so commonly used in its stead.

Some persons will at once raise the objection that the treatment of hides without the aid of tannin cannot be legitimately called tanning, and that the product obtained is not rightfully known as leather. It may be so: we will not enter into any discussion on mere words.

But surely if hides can be made serviceable for machine-belting, boots, harness, and all the numerous purposes to which leather is applied, what name we give either to the process or to the finished article is not a matter of first-rate importance.

Some time ago we noticed a process for tanning with certain preparations of iron. Now, however, chrome has been applied in the preparation of hides, and by its aid a mineral leather has been obtained, not as a mere experimental curiosity, but as an article of commerce. It is asserted that the chrome process is much cheaper than the ordinary methods of tanning; that to the tanner it yields as heavy hides as he can in other respects obtain; and that the leather thus made is in no respects inferior, but rather, in several important respects, superior to bark-tanned leather. For belts it has been proved to be strong, durable, and elastic, and, therefore, not liable to slip on the pulley. For the uppers of boots it offers the advantages of imperviousness to water, softness, and pliability, and is free from the tendency to get hard and crack. As soles for boots it excels other leather in respect of durability and power of resisting water. It is also said to be closer and finer in the grain than bark-tanned leather.

This process has been invented and patented by Dr. Heinzeiling. Nine tanneries in Germany have already adopted the process, and the chrome leather is extensively used by shoemakers, belting manufacturers, and others. In the city of Frankfurt alone not fewer than fifty shoemakers are already using chrome leather in their trade to the satisfaction, as it appears, of their customers.

In this country the Eglinton Chemical Company, of St. Vincent Place, Glasgow, have undertaken a general agency for the patentee, and are prepared to grant licenses and give instructions for working the process. They have, for the instruction of those interested, fitted up an "Exhibition Tannery," where all the details of the process may be seen, and where three hundred chrome-tanned hides are displayed, made up into belting, boots, etc.—*Chemical Review.*

DIRECT POSITIVE TRANSPARENCIES.

DURING his visit to this country, a few weeks ago, Dr. Vogel called our attention to a process which had recently been communicated to him of producing positives of a transparent character direct from nature. The method, which Dr. Vogel compared to one foreshadowed nine years ago by Colonel Stuart Wortley, but not practically elaborated by that gentleman, has now been published in the *Mittheilungen*, and, in support of it, Dr. Vogel tells us the author submitted to him a series of pictures, all possessed of surprising delicacy and harmony, evidencing plenty of proof of the value of the process.

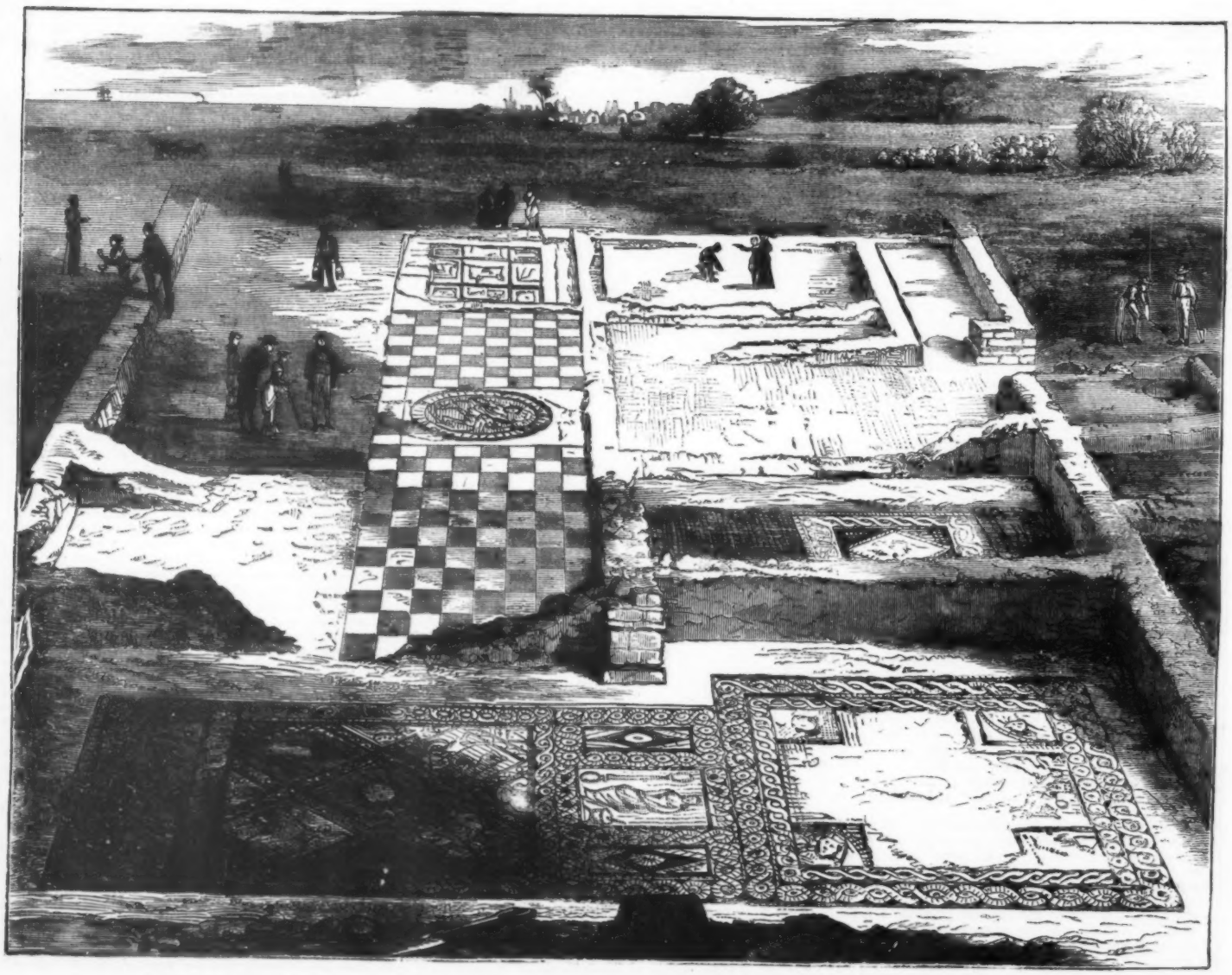
The elaboration of the process is due to an amateur, M. F. Jähns, a civil engineer, and one of the officials of the Rhenish Railway. Some time ago, he tells us, when experimenting with collodion emulsion and various kinds of developers, he put on one side a number of plates which had been developed, but not washed. On one of these plates, which had been fully developed, he found, to his astonishment, a patch about the size of half a crown, where the image was not negative, but positive. The positive portion of the plate was as clear, too, and finely detailed, as was the negative portion; in fact, in M. Jähns' own words, the positive was as beautiful and finely marked as any paper print from the plate could have been.

It remained, then, to find out how this transposition, or reversal, had come about. As the developer had not been washed from the plate, it was but natural to infer that its presence, and the subsequent action of diffused light upon the film, were the causes of so strange a phenomenon, and this, in the end, was found to be the case; making a series of experiments, M. Jähns found that, by permitting the developer to remain upon the fully-developed negative, there was produced, on allowing diffused light—or, better still, sunlight—to act upon it, a fogged plate. As the fogging came over the plate, the negative image gradually disappeared, and then soon afterward a positive image began to make its appearance, in which the lights and shadows of the original were reversed. There was, however, fog still remaining on the plate when the positive had been produced; for, although the fog could be, to a certain extent, kept down in the process of transformation by treatment with tincture of iodine, it could not be obviated altogether. Neither did subsequent bathing of the positive in a hyposulphite or cyanide bath effect the purpose satisfactorily; indeed, this radical treatment frequently, as might be expected, caused the image to disappear altogether.

M. Jähns next experimented with iodized collodion and an iron developer, but as no results were here obtainable, he was led to infer that the presence of ammonia was the key to the phenomenon. Ammonia was in excess upon the exposed plate, he reasoned, and dissolved the silver film formed on development in the dark room; further, the pyrogallic acid present at the same time developed, under the action of diffused light, such parts of the negative as had not been impressed in the camera. Dr. Vogel hardly thinks that the dissolving of the silver image in this way is probable; but we may here remark that we are only quoting M. Jähns' theory of his process.

To effect the dissolution of the negative image more energetically, M. Jähns employed strong nitric acid; this

SIR JOSIAH MASON'S SCIENCE COLLEGE, BIRMINGHAM.



ROMAN VILLA DISCOVERED NEAR BRADING, IN THE ISLE OF WIGHT.

answered the purpose completely in all cases where bromine salts were employed in the image, the positive image remaining behind on the plate clear and distinct. This positive had now to be exposed anew to daylight, under the action of a developer, in order to secure a plate free from fog.

Our readers will find in M. Jähns' process much that is already familiar to them; but we have Dr. Vogel's word for it that it is not a mere laboratory experiment that is here detailed, but a practical process whereby transparent positive photographs may be produced direct in the camera—the clear and delicate qualities of which vie with those of a thoroughly good negative.—*Photographic News.*

METHODS OF OBTAINING POSITIVES IN THE CAMERA.

By FR. JAHNS *

HAVING for a great many years as amateur availed myself of the help of photography in my profession, the introduction of emulsion processes, on account of greater convenience, was exceedingly welcome. Until the summer of 1876 I practiced the tannin process, which gave very unreliable results; and since then I tried the collodion emulsion, the management of which I have been obliged to find out for myself. In order to watch closely the results of my experiences, I kept a certain number of my trial plates, besides noticing each plate before it was washed off. Out of ten fully-developed negatives which had been treated almost alike, I remarked, in the center of one of them, a spot the size of a crown piece of an entirely positive nature, and more beautiful in gradation and half-tone than a paper print would have been.

The plate being perfectly dry, having remained about four days, an accurate determination of the remainder of the developer could not be made. By close observation it appeared that the positive spot must have been different to the surrounding negative portion before development, and that some preceding cause must have occasioned its formation. I therefore proceeded to experiment in every way by addition, or omission, in all combinations that circumstances allowed

After a series of thirty-two experiments I obtained a positive, although a foggy one, certainly, by submitting the plates, as soon as the negative image appeared, and with the developer still upon its surface, to the action of sunlight. Under the fogginess the outlines became completely lost, and then changed to a positive image in light and shade.

By the addition of strong tincture of iodine during the exposure to light the fogginess could be partially removed. The method of dipping in a bath of hyposulphite of soda or cyanide of potassium was not always successful, the whole picture disappearing in many cases.

Working from another standpoint, I tried the same method with iodized collodion which had been developed with iron, but no sign of the described action showed itself.

I can with certainty assert that the presence of ammonia gave a most essential impetus to the action.

The fogginess was also to a certain extent accounted for, since the dissolving of the negative precipitate and the formation of the positive took place at the same time, and could not be separately performed.

The best method of accomplishing separation was evidently by the application of nitric acid to effect the dissolving of the silver precipitate.

This method acted perfectly with all precipitates derived from bromine salts, and there remained then but that portion of the sensitive film which had not been acted upon by light in the form of a positive. The positive picture thus produced had again to be exposed to light under the action of the developer in order to obtain a silver positive free from fog.

The results appear to me excellent, and the skillful worker requires scarcely any further explanation in order to obtain a direct positive, the production of which, with regard to gradation of light and shade, can be proportionately increased in transparency.

I must just observe, however, that I have noted great differences in the action of various bromide of silver emulsions. They often seem to be attacked by the acid. This inconvenience is, however, to be obviated with absolute certainty by adding a few drops of bromide of potassium to dilute nitric acid; this compensates for that dissolved by the acid.

In astronomical photography and micro-photography the application of this method should be of considerable use.

* *Photographische Mittheilungen.*

ROMAN VILLA IN THE ISLE OF WIGHT.

THE discovery, by Captain Thorp, of Yarbridge, of Roman remains at Morton Farm, near Brading, in the Isle of Wight, has led to further researches of considerable interest. The Roman villa, at first but partially disclosed, is now being fully explored. In the illustration given opposite we are enabled to show the more important of the discoveries which have been made.

The extended excavations are on the estate of Lady Oglander, of Nunwell, who has generously afforded every facility for investigation. So likewise has the present occupier of the land, Mr. Micah Cooper, of Morton. The works have now been continued three weeks, under the direction of a committee of antiquaries, who are Messrs. Cornelius Nicholson, F.S.A., of Ventnor; John E. Price, F.S.A.; and F. G. Hilton Price, F.G.S., of London. They propose to raise by public subscription the funds which will be requisite to insure a complete exploration and the protection hereafter for the remains uncovered. Although several interesting chambers have been opened up, there are many indications of others which yet lie buried. It is impossible at present to describe the extent of the villa, or the purpose to which the respective apartments were adapted. The walls, none of which are known to be external, are mostly uniform in thickness. They are 2 ft. wide, and from 3 ft. to 4 ft. high, which are the usual dimensions of such walls. This affords further testimony to the opinion that the foundations only of Roman domestic buildings were of solid masonry, and that upon them was reared a superstructure of wood and plaster, with a roof of slate or tiles.

The walls are of flint, chalk, and rubble, bonded in the Roman manner with slabs, in courses, of stone taken from the locality, and probably from the shore near Bembridge. They are faced with squared blocks; here and there are intervening piers for the support of doors and columns, finely worked in like material. These walls have been lined with stucco painted in tasteful patterns, and much of which has been preserved.

The mosaic floors as yet disclosed already present wide field for study and conjecture. Two of them form part of a tessellated corridor or passage, upwards of 60 ft. in length, paved in a checkered pattern, the alternating squares being white and red. Upon the first of these mosaics is a composite design, grotesque in character, possibly symbolical, which may be connected with ancient mythology, or with the early introduction of Christianity. The meaning or intention of the strange figures which make up this combination is not yet ascertained. In the second pavement the design is such as can be readily explained. It is a compartment of about eight feet square, with a tasteful border of the guilloche pattern, formed of tesseræ of varied colors. Inclosed by a circle is a figure of Orpheus playing on his lyre, and attracting around him a monkey, a fox, some birds, and other animals. Some of the tesseræ which form the plumage of the birds have been tastefully and artistically selected. This room or corridor leads to the largest apartment which has yet been cleared. This is nearly 40 ft. long by about 18 ft. wide. Midway are two piers of masonry for the support of columns.

At the western end is a mosaic, which, though much injured, will, like that more perfect one in the eastern division, bear comparison with any similar remains yet discovered in Great Britain. The designs are mostly of a mythological and pastoral character; figures of the Seasons, of the fable of Perseus and Andromeda, and some connected with the pursuits of agriculture, together with groups engaged in dancing and playing on pipes and tambourines; Mercury-looking figures blowing the *bucina* or horn of spiral twists, such as were used by the ancient neatherds to collect their flocks. In the center is a bearded figure, apparently an astronomer, surrounded by objects connected with his profession. In an adjoining room is a pavement of a coarser character, with a plain geometrical pattern formed of inch-sized tesseræ, gray, white, and red.

Upwards of a dozen chambers have been examined, but their uses are not yet understood. Flues and furnaces, showing the way in which the rooms were warmed, and adapted to habitation, are in course of excavation. Some pottery, pieces of glass, bones of domestic and other animals, fresco paintings, ridge and roof tiles, together with quantities of iron nails, belonging to the slabs which once formed the roof, have been taken from the *débris*.

The coins, also one of the most interesting features of the work, point to the period when the buildings were occupied; they at present illustrate the reigns of Gallienus, Victorinus, Tetricus, Carausius, and Constans; the last bringing the date down to the early part of the fourth century.

It is hoped that the committee of explorers will be so encouraged and assisted as to be able to complete their work, which has already attracted a large number of visitors to the island.—*Illustrated London News.*

SIR JOSIAH MASON'S SCIENCE COLLEGE, BIRMINGHAM.

THE opening of this institution was celebrated on Friday, 1st October, with an address by Professor Huxley in the town hall, a luncheon at the Queen's Hotel, and a soirée in the rooms of the college. The buildings have been five years and a half in construction. The foundation stone was laid on Feb. 23, 1875, that being the eightieth birthday of Sir Josiah Mason, the founder. The site comprises about an acre of ground, but only half of the area is at present occupied by buildings. The front elevation, in Edmund Street, as will be seen by the engraving opposite, is of a very imposing character. It is in the Gothic style of the thirteenth century, with details and embellishments of an elaborate design. The edifice, with its hundred rooms and three hundred and seventy windows, rises to a height of 122 feet. In the apartments assigned to the use of the several professors, every provision is made for scientific teaching, all the principal science colleges of this country and of the Continent having been inspected by the architect before the plan was passed by Sir Josiah Mason and the trustees.

The foundation deed specifies that the instruction provided in the college shall consist of mathematics, physics, chemistry, geology, mineralogy, metallurgy, botany, zoology, physiology, the English and French and German languages, with such further extension as the trustees may consider desirable. There are at present six trustees, appointed by Sir Josiah Mason, who himself holds the title of Bailiff; but in future the number is to be eleven, and five are to be nominated by the Town Council of Birmingham. The object of the institution is to afford a thorough scientific education, especially with reference to manufactures, and to mines and metallurgy, and to the laws of health. At present four professors have been appointed in the departments of mathematics, physics, chemistry, and biology; but an extension of the scheme may be expected when the results of the first term have been ascertained.

Sir Josiah Mason has endowed the college with property consisting of freehold land and houses in Birmingham, yielding upwards of £3,000 a year, and has paid all the expense of building and fittings, likely to reach about £60,000. As he founded and endowed, some few years ago, an orphanage near Birmingham, at a cost of more than a quarter of a million, an idea may be formed both of his wealth and of his beneficence. Although of such advanced age, Sir Josiah Mason has personally superintended the building from first to last, engaging no contractor for any part of the work, but relying entirely on his own judgment and the skill and experience of Mr. Cossins, the accomplished architect. On the occasion of laying the foundation stone, he gave some account of the incidents in a career which had enabled him to confer such large benefits on his fellow-men. It was mentioned that he came from Kidderminster to Birmingham a poor lad, in search of a living; that he worked at a variety of trades; that he devoted his first savings to making steel pens (then selling from the manufactory at a shilling apiece) under the auspices of Messrs. Perry; that his works grew to become the greatest pen factory in the world; and that he subsequently engaged in the electroplating and copper trade with Messrs. Elkington, and in the German silver trade, which he still carries on. The pen trade of Sir Josiah Mason is now transferred to the joint stock company of Perry & Co.—*Illustrated London News.*

SETTEE, EASY CHAIR, AND SMALL CHAIR, THE FRAMES IN BLACK-STAINED WOOD, THE COVERING IN BLUE SILK WITH PATTERN, FROM THE DESIGN OF H. DUHRING BY DUBELL, CABINETMAKER AND DECORATOR, VIENNA.—*From the Workshop.*

ST. MARK'S LIBRARY, VENICE.

THE history of the library, which enjoys a world-wide fame for its Greek, Latin, and Oriental codices, its objects of art and antiquity, and the modern works, is a curious legend, and may not be known generally. Francesco Petrarca, having been sent to Venice on a special mission by his master, the Duke of Milan, was so pleased with his sojourn in Venice that, in the year 1362, he took up his permanent abode in the house of Arrigo Molin, on the "Riva degli Schiavoni." It having occurred to him afterwards to institute a public library, he made a present of his valuable books to the Venetian republic, with the following letter: "Francesco Petrarca, being desirous of having for his heir the pious evangelist, St. Mark, if so pleases to God, hereby bequeaths to him all the books he now possesses, or may possess in future, on condition that they should not be sold or spoiled in any way, but preserved in a proper place where there is no danger of damp or fire, in honor of the saint above mentioned, in memory of him, the said Francis, and for the perpetual consolation of the nobles of this city who may interest themselves in such matters." The books were then placed in a small room close to the famous four horses on St. Mark's Church. In 1422 the Senate began to purchase some books for the institution of a library. The example set by Petrarca was subsequently followed by many others. First of all, Cardinal Bessarione, Patriarch of Constantinople, through the inducements of the Venetian ambassador to that court, presented to the republic a precious collection of valuable ancient books and manuscripts, in Greek and other languages, saved by him after the ruin of the Grecian Empire and the capture of Constantinople. On the receipt of the books, which were forwarded to Venice in thirty cases by the ambassador, the republic decreed that they should be placed in a hall of the ducal palace. In 1589, Genlandino Melchiore, of Marienberg, bequeathed all his books to the republic, with a legacy of 1,000 scudi for the erection of proper bookcases. The Patriarch of Aquileja bequeathed afterwards to the library all his precious books, among which is the famous manuscript called "Grimani's Breviary" bound in velvet and silver, and containing inestimable miniatures. In 1560, Jacopo Contarini left to the library all his rich and voluminous works, among which there was the original book of architecture by Palladio. Antonio Dei Vescovi, Gasparo Ventura, Pietro, Morosini, Giovanni Recanati, Nicolo Manuzzi, Domenico Pasqualigo, Monsignor Fontanni, and many other illustrious persons, left subsequently precious works, maps, and globes to the library. The Venetian republic afterwards enacted that a copy of all books of any kind published in its dominions should be sent to that institute. The library, which is still in the ducal palace, is opened every day, except on Sundays, from 9 A.M. to 3 P.M., and the entrance is free to natives and foreigners.—*The Architect.*

ROOF COVERING.

THE following table will be found of service by those who wish to calculate the loads on roofs. The weights are given in pounds per square foot:

Slates	5 to 11
Tiles	7 to 20
Pantiles	10
Boarding, ¾ in. thick	2½
Sheet-iron (16 w. g.) and laths	5
Corrugated iron and laths	5·5
Sheet lead	7
Sheet zinc	1·25 to 1·63

In iron roofs, a common truss of 50 feet span will weigh about 3 to 5 pounds per square foot of area, though many large railway-station roofs constructed on the bowstring or arched principle, weigh from 10 to 24 pounds.

SIR WILLIAM THOMSON'S SIPHON RECORDER.

THERE are important impediments met with in submarine telegraphy, and they have been overcome only by the long and persevering efforts of a large number of scientists, engineers, and capitalists. The failures of the first attempts to lay cables, and the slowness with which transmissions were effected in the beginning, might have rendered the project fruitless; but happily the improvements introduced by Sir William Thomson have wrought a transformation. A submarine cable, in fact, has certain special characters which prevent the use of the ordinary Morse, Mayer, Baudot, etc., apparatus beyond a certain length. When an electric cable is put in communication with a pile, the current which traverses it does not instantaneously assume the intensity answering to the strength of the battery and the total resistance of the circuit. We will content ourselves in pointing out the cause of this fact, and which resides in the *electro-static capacity* of the cable; the said capacity being dependent upon its length, form, size, and the nature of the materials composing it.

A numerical example will show very well how the current circulating in a submarine line is retarded—in the cable, for instance, connecting England and Newfoundland.

When a current is sent into this cable, two-tenths of a second after the exact instant of contact no apparatus—even the most delicate—can be influenced by it at Newfoundland. Four-tenths of a second after emission the current reaches seven hundredths of the maximum intensity which belongs to it; and in one second it will reach about fifty per cent., and will take *more than three seconds* to obtain its normal intensity. In the French cable, the capacity and length of which are greater, it would take *eight seconds* for the current to reach this maximum. Such being the case, it would take *two minutes* to transmit a word by means of the dots and dashes of the Morse apparatus; and transmission would be reduced to thirty words per hour, thus necessitating the fixing prices of telegrams at figures beyond reach, on account of capital engaged, funding debts, etc. It results from this, then, that the emissions of the current should succeed each other more quickly, and that, consequently, the current has not the time to regain its normal intensity at the end of the line.

At the present time, we can telegraph fifteen to seventeen words per minute through a cable. The duration of the current which corresponds with one dot does not exceed twenty-seven hundredths of a second, and the intensity at the end of the cable after this time is often less than one-thousandth of that which the permanent current would take when the regimen has once been established. On another hand, the successive currents sent over a line react on each other; they become superposed, just as waves of a liquid do, so that the intensity corresponding with a given signal often depends on the twenty or thirty preceding emissions of the current. A *regular* transmission of currents from the forwarding station becomes at the receiving station an *irregular* series of signals. It is impossible for a Morse apparatus to operate under these conditions, and it is the same with all other apparatus in which a given intensity is requisite in order to move a pallet or an armature. The mirror galvanometer of Sir William Thomson resolved the problem from the very start. The luminous ray on moving before the graduated scale follows all the variations of the current's intensity, and operators soon acquired the necessary skill to interpret all its movements, which are apparently so irregular. The mirror galvanometer, however,

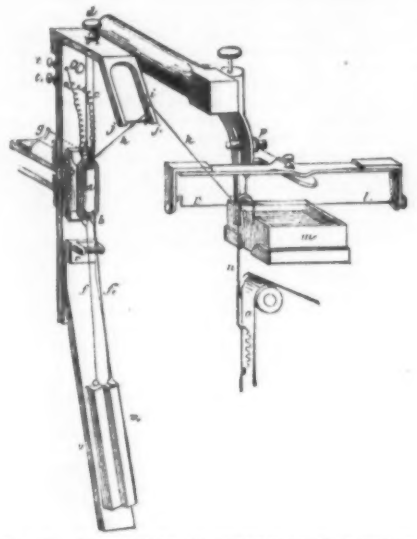


FIG. 1.—SIR WILLIAM THOMSON'S SIPHON RECORDER.

presents two grave inconveniences; for it leaves no *material* trace of the signals sent, and the operator charged with interpreting the messages by the movements of the luminous ray becomes in a short time greatly fatigued, this often giving rise to numerous errors, and necessitating repetitions and a consequent loss of time, and so contributing to diminish to a certain extent the traffic of the line.

The *siphon recorder* of Sir William Thomson that we are now going to describe does away with these difficulties by tracing on a strip of paper a continuous curve, which is nothing else than a material representation of all the move-

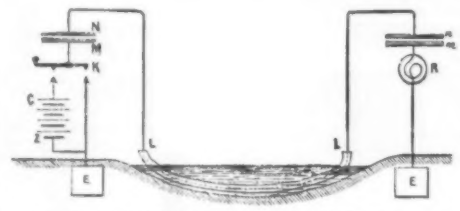


FIG. 2.—DIAGRAM SHOWING ARRANGEMENT OF SUBMARINE CABLE.

ments of the apparatus under the influence of the currents sent by the transmitting station; this curve representing at each instant the strength of the current which is traversing the apparatus at the receiving station. The receiving operator then has only to read the signals and transcribe them, not as before at the very instant they are produced, but at leisure. The key to the conventional characters is soon mastered. The continuous curve is traced on the strip, *o* (Fig. 1), by the extremity of a very fine glass tube, *n*, filled with aniline ink drawn from the reservoir, *m*. This tube or siphon is pulled backward and forward, in one direction,

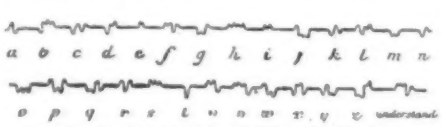


FIG 3.—SIPHON RECORDER ALPHABET.

by the threads, *k* and *h*, and the lever, *i*, by means of a very light swinging coil, *b b*, which is suspended between the poles of a very powerful electro-magnet, not represented in Fig. 1. A stationary core of soft iron, *a*, is placed within the coil, *b b*, and the latter is suspended at *d* by the wires, *c*, and is directed by the two wires, *f f*, which support the wights, *w w*. The coil, *b b*, swings upon a vertical axis in the magnetic field of the electro-magnet, according to the direction of the current traversing it. The tension of the threads, *h* and *k*, is adjusted by the spring, *g*. Thus arranged, the masses in motion being very light, there is

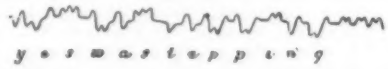


FIG. 4.—MESSAGE TRANSMITTED BY SIPHON RECORDER.

scarcely any inertia to be overcome, and the apparatus is for that reason very sensitive. The electro-magnet, between the poles of which is located the coil, *b b*, is charged by a special local battery. This battery, combined for the present purpose by Sir William Thomson, is nothing else than a Daniell pile having a large surface and consequently yielding much in *quantity*. It serves also to put in motion a small electric motor located above the siphon recorder, and the function of which is a double one, that of causing the paper band, *o*, to move at a uniform rate, and that of electrifying the ink contained in the siphon, *m*. To effect the latter, it puts in motion a miniature Holtz machine, and the flow of electricity produced by this, finding no other passage to the earth than that through the tube, *n*, causes a flow of ink from the reservoir, *m*, through the siphon. It is not necessary, then, that the point of the siphon should touch the paper band, *o*; they are therefore some millimeters apart, and the ink is ejected upon the paper in a succession of fine dots, forming a continuous line. The width of the paper band does not exceed seven-tenths of an inch.

Fig. 2 shows the arrangement employed in transmitting submarine messages by the siphon recorder. It will be seen that the current from the battery is not sent directly into the line. The idea of interposing condensers is due to Mr. Varley. These consist of a large number of alternate sheets of tin foil and paraffined paper, or mica, interleaved, and connected as in the condensers of the Ruhmkorff coil. The line, L, is attached to the insulated armatures, N and *n*, of two large condensers. At the transmitting station the second armature is attached to a key, K, which allows it to communicate with the battery, C Z, or with the earth, E. At the receiving station the second armature of the condenser is connected with the earth through the medium of the coil, R, of the siphon recorder. On pressing the key, K, M is connected with the positive pole, N becomes negative by induction, and a current is established from N to *n*, and *n* becomes positive and *m* negative by induction; and, to effect this change, a current of short duration is established from *m* to the earth, E, through the coil, R, making the desired signal in a certain direction. The current begins abruptly, has little intensity, and afterwards becomes gradually weak. Its weakening may be hastened by releasing the key and connecting M with the earth by the contact, K. A negative signal is sent by connecting M with the *zinc* instead of the *copper* of the battery. There is then set up in the line, not a *current* properly so called, but only a series of induced currents produced by the charge from the condensers in one direction or another, and these induced currents are shown by a series of impulses in one direction or another which are communicated to the bobbin of the siphon recorder. The transmission of currents alternately in an opposite direction is effected by the aid of a double key not shown in Fig. 2. Owing to Mr. Varley's arrangement, the current received by the instrument, R, never increases beyond that which produces the first signal; the swing of the bobbin is then limited, and this also allows of the limiting of the width of the paper band. Fig. 3 represents the conventional alphabet employed, and Fig 4, a message sent by the condenser and siphon recorder. The speed of transmission in a transatlantic cable, or one of equal length, either with the mirror galvanometer or the siphon recorder, varies between fourteen and eighteen words per minute.

It remains for us to say a few words about the duplex arrangement, which, for a few years past, has enabled the working capacity of submarine cables to be doubled. The ordinary duplex arrangement for sending telegrams simultaneously over the same wire in opposite directions works perfectly on short lines; but, for longer ones, owing to the static capacity of the cable, induction, etc., several difficulties supervene, and in submarine cables these difficulties are still further increased by the great length and the nature of the conductor. After long researches and numerous experiments by Messrs. Varley, De Sauty, Taylor, and Muirhead, a solution of the problem has been effected. The cable from Aden to Bombay, provided with the duplex system of Muirhead, is about 2,230 miles long. By using the Thomson siphon recorder as a receiver at the termini, each station can transmit a hundred letters per minute, or a total of forty to forty-five words per minute. The capacity of the cable is thus more than doubled, because the loss of time caused by signaling, and changes of communication according as the station was to send or receive, is avoided. With a *duplex* the cable is *always* ready to receive or transmit. From these remarks it will be seen that the mirror galvanometer, the siphon recorder, and the duplex arrangement constitute three inventions without which submarine telegraphy would have been unable to render service on long lines.

APPARATUS FOR THE DETECTION OF FIRE-DAMP IN MINES.

THE dangers connected with the presence of carbureted hydrogen in the coal pits are probably known to all our readers. This gas, which the miners call fire-damp, when mixed with atmospheric air in certain proportions, will explode at the approach of light, suddenly and with violent detonation, producing frequently horrible disasters. These terrible explosions can be partially prevented by using Davy's safety lamp, which has been somewhat modified since it was invented by the great English chemist, but, nevertheless, they occur very often, and it is an act of great merit for Mr. Coquillon, Prof. of Physics of Charleville Lyceum, in France, to have invented an apparatus which is specially adapted for the analysis of the atmosphere in mines, and for the quick detection of the quantity of carbureted hydrogen present. The gas is measured over water in a graduated tube. The mechanism for the displacement of the gas in the apparatus is perfectly analogous to the apparatus of Mr. Orsat (for the analysis of gas). It has the same sort of water bottle, which has on the lower end a tubulature connected with a rubber tube, which establishes a communication with the measuring tube. (The gas may either be introduced into the apparatus in the mine itself, or brought into communication with the tube previously filled with water, which has served for collecting the sample of air in the interior of the mine.)

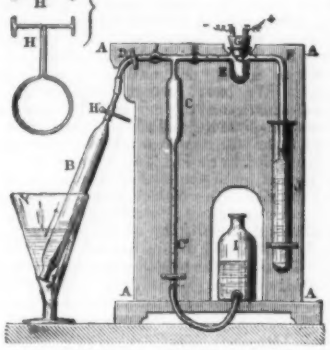
For the reason that no matter is known which is capable of absorbing the carbureted hydrogen gas at an ordinary temperature, the apparatus is furnished on one side with a reservoir containing a spiral of palladium wire. This wire is rendered incandescent by the passage of an electric current which is produced by means of a small battery. When the gas is measured it is made to pass several times around the incandescent spiral and combustion without detonation takes place, while at the expense of the oxygen contained in the analyzed sample of the atmosphere carbonic acid and water is formed. It is well known that a volume of carbureted hydrogen, for its complete combustion, and for the formation of an equal volume of carbonic acid, needs a volume of oxygen, which is double of that which it contained previously; upon this property the calculation of the amount of carbureted hydrogen present is based. The half of the absorption, or of the diminution of volume which follows the combustion, indicates the amount of fire damp.

The measuring tube is so graduated that the quantity of fire damp can be read off without correction, and the indication is exact to 0·01 of its volume. The following is an explanation of the single parts of the apparatus which is represented in our illustration, Figs. 3 and 4:

Fig. 3 shows the complete apparatus. Fig. 4 represents Mohr's forceps for burettes. A A, a vertical board mounted upon a table to which the tubes of the apparatus are fastened. B, glass tube for collecting sample of air in the mine, its lower part being immersed into a glass filled with water. C C^1, measuring tube whose lower and thinner part is graduated, and whose upper part communicates by means of a tubulature with a horizontal capillary tube, D E F. This capillary tube is bent at its extreme ends, and is connected with the tube, B, by means of a piece of rubber tube; it is also furnished with two glass taps, 1 and 2, which are situated on the right and left sides of the measuring tube, C and C^1. E represents a swelling of the capillary tube, D E F, and is an opening which can be closed by a special stopper, G. This stopper is made of India-rubber, and is pierced by two pieces of copper wire, which are the electrodes of the above-mentioned battery. These electrodes are connected inside of the cavity, E, by the spiral of palladium wire. H is a Mohr's forceps, which serves to press the piece of rubber tube together when the communication between the tube, B, and the rest of the apparatus has to be interrupted. I is a bottle filled with water, connected at the lower end by means of a rubber tube with the lower end of the measuring tube, C C^1. According to the raising or lowering of this bottle the pressure can be regulated at will. J is a test tube into which the lower end of the elbow, F, is immersed. The gas is measured when the water level in the tube, I, and the measuring tube, C, C^1, are equal. For the purpose of measuring, the tap 1 has to be kept closed while the tap 2 has to be opened, thus permitting the mixture of the air and the carbureted hydrogen to occupy the space, C_1 C E J. After this is done an electric current is led through the palladium spiral, which is heated to a red heat, and by moving up and down the bottle, I, the gas is made to pass the spiral several times, thus producing a complete combustion of the fire damp at the expense of the oxygen contained in the air present.

B

Fig. 4.



APPARATUS FOR THE DETECTION OF FIRE-DAMP IN MINES.

THE PHENOMENA OF FLUORESCENCE.

By EDWARD RATTENBURY HODGES.

Now and then it happens that Dame Nature "lets the cat out of the bag," or, to speak more philosophically, she reveals some hitherto unnoticed and unknown fact or phenomenon which takes us by surprise.

The exhibition of this to the young or old, the learned or unlettered, is invariably followed by the ejaculation—How beautiful! how wonderful! No matter how diversified our habits, gifts, or tastes, we feel a common interest in the thing, and mutually share the sentiment of pleasurable surprise. We think it may fairly be said that the movement of a comet through space, or the motions of a creosote drop upon a water surface, are alike equally worthy of our attention and our thought; for He who made the glowing gases of the one also formed the oily particles of the other, and fully intends us to augment our knowledge and exercise our reasoning faculty as much by a careful contemplation of these as of other phenomena. By this delightful mental exercise we insensibly learn to observe and reflect at one and the same time, in consequence of being brought into direct contact with what a great leader in science has aptly termed "objective realities." From an abstract point of view there is a curious correlation to be found in the examples just given. The astronomer makes his calculations upon the vast elliptical orbit of the former, while the physicist makes mathematics explain the fitful gyrations of the latter. And we might pursue the analogy still further were it necessary.

While candidly admitting that much is being done to popularize the facts of physical science, it is surely justifiable to ask that the *rationale* of many of its doctrines should also be made sufficiently simple as to find ready access to minds of ordinary capacity. To take any material object and detail its various known properties in plain language is by no means difficult; but to describe the various known laws which govern its character is, on the other hand, not an easy task, for at this point we travel out of the region of the material into that of the immaterial. In other words, we move away from the domain of the concrete and enter the kingdom of the abstract.

The bodily eye looks at the material, and then the mental one looks at the immaterial or invisible, and sees how inseparably connected is matter with force.

These observations may well apply to the remarkably interesting phenomena of fluorescence, or "internal dispersion," for such are the terms given to the modifying effect produced by certain chemical substances upon a particular kind of light-energy which may be made to fall upon them. The phenomena appear to have been first observed in 1833, by Sir D. Brewster, in an alcoholic solution of the green coloring matter of leaves.

About ten years later Sir John Herschel made further observations, and subsequently published a paper on the subject in the "Philosophical Transactions" for 1845. Since then Prof. Stokes, of Cambridge, and other observers in England and on the continent have been making further researches in fluorescence.

Without detailing the history of the investigations connected with the subject, we give our readers some of the more interesting and remarkable facts which have been gleaned of late years, as well as some account of the earlier discoveries.

If we put some common paraffin oil, or a solution of sulphate of quinine, into a glass tube or other suitable vessel, and then look through it, the liquid will appear quite colorless; but if we allow the light to fall upon it, and then view it at a little distance and at a certain angle, some parts of the liquid will present a delicate sky-blue tinge. The effect in the case of quinine is heightened if the source of light is burning magnesium wire.

The large number of substances belonging to this class are termed fluorescent bodies, because they exhibit phenomena similar to the examples above given. The term itself, however, was suggested to Prof. Stokes by a particular kind of fluor-spar which shows this property.

Again, if we cause a room to be darkened, and allow only blue light (*i. e.*, by covering a hole in a window shutter with cobalt-blue glass) to fall upon a glass vessel filled with water which has been standing some minutes, on floating a strip of horse-chestnut bark upon its surface, in a few moments a stream of bluish-gray fluid (æsculin) will be seen slowly descending from the bark, hanging, in fact, like a bunch of barnacles from an old ocean waif. Or if, under the same arrangement of light, or by using even more powerful absorbents of the ordinary rays (such as a solution of ammonio-sulphate of copper or one of chromate of potash), we look at a piece of what is commonly termed canary glass—*i. e.*, glass colored with an oxide of the metal uranium—it will be seen to glow, as it were, with rich greenish yellow rays, just as though it were itself a source of light; or if we take a solution of a uranium salt (the normal acetate) the phenomena are very striking when examined under the same conditions, and still more so by the electric light. But the salts of aniline—a substance which is the parent, so to speak, of mauve, magenta, and other brilliant colors—are similarly rich in exhibiting these effects.

A very beautiful experiment may be performed with the aniline red ink now so commonly in use. It affords, at one and the same time, an admirable illustration of Prof. Tomlinson's submersion figures and of the phenomena under consideration. If we take a long cylindrical glass vessel, or one with parallel sides, fill it with water, which is allowed to settle, and then gently deliver a drop of the fluid to the surface, the drop begins to contract, and slowly from its center descends in the form of a tube; the denser parts of the coloring matter presently form a thick circular rim at the end of the tube—but this is only for a moment, for a wavy edge appears upon this rim, then expands into a triangular parachute with a thickened edge, and from the extremity of each corner two or three smaller tubes descend; these in like manner pass through the same phases as the parent stem or tube. When this beautiful figure is viewed by transmitted light it exhibits the ordinary bright red color; but when placed against a very dark background, and looked at from a little distance and at an angle, it is seen to be of a brilliant green,* very like a curious seaweed serenely floating in a summer sea. Viewed vertically it presents a most singular shape, and glows with a fine golden tinge. Chlorophyl, the green coloring matter of leaves before mentioned (those of the nettle are preferred) by reflected light is bright green; but when a beam of white light concentrated by a lens is sent through it, the path of the beam is of a blood-red hue.

Crude resin oil, which is almost opaque, presents a delicate sky-blue fluorescence at its surface and the side opposite the light. One investigator has shown that some coloring matters obtained from different woods, which, though soluble in alcohol, alkaline solutions, or in alum, and not in this way sensitive, are very brilliantly fluorescent when dissolved in castor oil; the most marked among them is camwood; in this medium it shows a strong apple-green fluorescence.

When paper is written upon with a tincture of stramonium seeds the characters are quite invisible by ordinary light, but appear self-luminous when exposed to highly refrangible rays, such as those given out by burning sulphur in oxygen.

Fluoraniline (obtained by acting upon aniline with chloride of mercury) is said to be one of the most powerful fluorescent bodies at present known.

The tinctures of several vegetable substances have a marked effect on light in this way: that of stramonium gives a pale but lively green fluorescence; guaiacum, a beautiful violet color; turmeric, a greenish tint. Two artificial coloring matters, fluorescein and eosin, exhibit this property in a truly remarkable manner; but the effect is most brilliant in the green and blue portions of the spectrum (*i. e.*, the rainbow band of color obtained by decomposing light by a prism).

A decoction of madder in a solution of alum shows a high degree of sensibility; it displays a copious yellow light. A weak solution of archil, which is red or purplish by transmitted light, gives a somber green fluorescence.

But Stokes found that the electric light (from carbon-points) gave a spectrum, by the aid of a train of quartz prisms, which was more than six times the length of the ordinary spectrum. This light is, in fact, very rich in what are called the highly refrangible rays, and, moreover, its effect on fluorescent bodies was strikingly beautiful, and especially in the case of uranium glass.

As to the explanation of these phenomena, physicists are still somewhat at variance. But the experimental researches and elaborate reasoning of Prof. Stokes, who is at present the chief investigator in this department of inquiry, led him to the conclusion that beyond the visible spectrum there are certain rays which ordinarily are not sensible to the eye, but when these highly refrangible or much-drawn-apart rays are allowed to fall upon certain substances the molecules of these substances are made to vibrate in slower periods than the exciting rays, these molecular vibrations react on the ether, and consequently the rays on emerging (*i. e.*, on reflection) are hindered in their course and lowered in their refrangibility, that on being thus reflected they are brought within the range of vision; that is to say, if a ray of white light be made to traverse a prism, all those rays which go to make up the beam of white light, instead of passing through and being bent at the ordinary angle of simple reflection, are spread out like a fan; the degree of divergence from the line of simple reflection represents the amount of refraction. The difference in degrees of refraction constitutes the difference between one color and another, and one shade of color from that which is akin to it.

That some rays are bent at a more acute angle than others is only another way of saying that they are more spread apart, dispersed, or more refrangible than others. For example, the yellow part of the spectrum consists of more refrangible rays than the red, and the violet than the green, and so on. But beyond each end of this rainbow band, or visible spectrum, there are the invisible rays. Those at the violet end are of very high refrangibility, and their motion as ether waves is also of very quick periods, while those beyond the red end are of low refrangibility and of comparatively slow undulatory periods. Now inasmuch as ordinary white light, or even diffused daylight, contains within itself those other highly refrangible rays, as well as those which are visible, it follows that when this light falls on a fluorescent body the substance absorbs or quenches those rays, and gives back rays which are of slower periods. This, then, is a kind of *selective absorption;* consequently those highly refrangible rays which, as it were, survive, in the course of their egress are evidently retarded within the molecules of the sensitive substance, to which molecules they impart their motion; these in their turn and by their movements excite or react upon the ether, and cause it to vibrate in waves of slower periods than the incident waves, which latter may be of any degree of refrangibility. It is very difficult to account for the phenomena otherwise. Moreover, it was found that if the incident light was polarized, the fluorescent rays from this source showed no traces of polarization; they are, in fact, *always* unpolarized. Fluorescent rays were also found to be totally incapable of producing the same effect in a like sensitive body. And here it must be remarked that Prof. Stokes' original paper on the subject, entitled "On the Change of Refrangibility of Light" ("Phil. Trans.," 1852), furnishes one of the finest examples of inductive reasoning to be found in the literature of physical science. However, it must be borne in mind that some investigators are not satisfied with Stokes' theory, and especially when he laid it down as a law that the light emerging from a fluorescent body under excitation is *always* of lower refrangibility than the incident rays.

Thus Prof. Angström, while agreeing with Stokes in some respects, considers that the molecular motions of the sensitive substance, on the contrary, by acting on the luminiferous ether, originate rays of higher refrangibility, the analogy to which might be, for example, as a higher octave in musical sounds. But this is considered by another authority as amounting to negative fluorescence.

M. W. Eisenlohr is of opinion that the phenomena are caused by the interference of the bluish violet and the ultra violet rays, which, it is argued, would give rise to rays of lesser refrangibility, in the same way as "combination tones" are of a lower pitch than the tones taken separately. But Prof. Bohn considers that according to this opinion fluorescence could never be seen in a spectrum that was pure, because "*there* rays of only *one* degree of refrangibility are to be found at the same place."

Prof. Lommel combines the theories of Stokes and Eisenlohr, but is of opinion that he has discovered a series of substances (anthracen blue among others) which do not obey Stokes' law—*i. e.*, that a body in the act of fluorescence never emits rays which exceed the refrangibility of the incident or exciting rays.

The results of Lommel's researches, it was reported, were corroborated by Brunner (of Prague) and Lubasch (of Berlin). But Hagenbach, the author of some very accurate studies of the phenomena, could not arrive at Lommel's results. M. Lamansky, however, after repeating the experimental work of his contemporaries, announced last year that, notwithstanding the facts and arguments adduced by Eisenlohr and others, he had nevertheless fully confirmed the validity of Stokes' law. This he accomplished by devising a means of *measuring the difference* between the incident or exciting rays and those simultaneously emitted by the substance under excitation—*i. e.*, the fluorescent rays. This he ingeniously effected in the following way: Reflecting the solar rays by a heliostat, and concentrating them upon a narrow slit by the aid of an achromatic lens, he then placed two flint glass prisms behind the slit and another achromatic lens, the latter being put at twice its focal distance from the slit. By this arrangement he obtained a spectrum of such purity that the chief lines were rendered visible. The spectrum was then thrown on the side of a box provided with a movable slit capable of adjustment to the several parts of the spectrum, and also provided with a means of widening or narrowing as might be required. Through this slit certain rays of the spectrum, which had been previously made to pass through a flint glass prism, entered the box, within which was a vessel full of fluorescent liquid; then by the aid of a reflecting prism these perfectly homogeneous rays were directed upon the liquid. An achromatic lens was then placed between the surface of the fluid and the slit; a colored image of the slit upon the liquid surface was thus produced. With another reflecting prism the fluorescent light was directed into the slit of the collimator of a Brunner's spectrometer. On looking through the instrument two colored images appeared in the field of view; one was the fluorescent light, and the other that reflected directly at the surface of the fluid. Nothing more then remained to be done than simply to measure the minimum deviation of these two images. Each of the experimental measurements showed invariably "that the fluorescent substance has a lower refrangibility than the incident light."

Quite recently, however, Hagenbach has announced that after a prolonged investigation he has fully come to the conclusion that at present there exists no reason for rejecting the law of Stokes, and, moreover, that Lommel's classification of fluorescent bodies is not based upon any essential difference in their behavior.

But the question as to the practical utility of these discoveries naturally arises. Science has a satisfactory reply. When each of these fluorescent bodies are examined with the spectroscope they exhibit well-marked and characteristic absorption bands or dark spaces; consequently we have here a most subtle means of detecting their presence in a mixed solution or in a free state. Not only so, but Prof. Stokes has pointed out that if, on examining a solution in a pure spectrum, "we find the fluorescence taking a fresh start with a different color, we may be almost certain that we have to do with a mixture of two different fluorescent substances, the presence of which is thus revealed without any chemical process."

Nearly two years ago, however, a most singular inquiry was brought to a satisfactory issue by the aid of fluorescence. It was long a question whether or not the head waters of the Danube found their way through subterranean passages into the Aach. The problem was thus solved: 10 kilos (about 23 lb.) of fluorescein were poured into the first named river, and three days afterward a splendid green coloration with golden reflections (*i. e.*, its fluorescent effect) was quite distinct in the waters of the Aach. It was estimated that in this way 200 millions of liters of water were colored by the presence of this substance. Doubtless science will apply these beautiful phenomena to other and even greater ends than those which have yet been attained.—*Journal of Science.*

* The brilliancy of color, of course, depends on the amount of diffused daylight. The effects in each case are best seen on a bright day.

CHLOROZONE.

FROM reliable information on the effect and results of this article, recently improved in a remarkable degree here, it appears that it really supersedes chloride of lime in quality and economy, especially on goods of a certain value, such as calico, spool-thread, hosiery, fine twine, shoe thread, linen fabrics, jute goods, etc.

The total absence of deterioration in the texture, even the most delicate—when properly handled—is an established fact. It is also admitted that the printing and dyeing applied on fabrics thus bleached acquire a positive superiority in brightness and fastness. The finishing of the goods seems also to gain by it some decided advantages, from the fact that one of the characteristics of chlorozone is to impart softness and gloss to the fiber.

The suppression of acids is another good point in favor of the improved article. Every manufacturer suffers more or less directly from the latent destructiveness and oxidation left in goods treated by chloride of lime and acid. This reform contains in itself an important item of economy, not only in the corrosive material itself, but in the subsequent handlings and washings it necessitates. Considering also the cost, inconvenience, and labor, rooms and utensils required by the use of chloride of lime with acids, compared with the easy, simple, and clean process of chlorozone in carboy, there must be notable savings all over, besides the plus value of the superior results. On the face of the facts known by new experiments there seems to be no doubt in the ultimate adoption of this new method over the old and crude process of bleaching by a direct contact with lime and acid.

The principles from which chlorozone is produced are scientifically correct and chemically true. Ozone, as everybody can verify in any dictionary or chemistry book, is an essential part of the natural oxygen acting on the globe as a providential purifier and bleacher. It bleaches, naturally, vegetable color and discolors dyed goods exposed to the air in combination with the sun's rays.

It converts indigo into a colorless isatin. This fact permits any one to verify the identity of chlorozone as a genuine product. A drop of chlorozone on a drop of indigo solution will turn this colorless. Another fact proving that it has no relation with chloride of lime is, that soap will amalgamate with chlorozone, while it will not with chloride of lime, which curdles and decomposes it in granulation. In this respect, a new application of chlorozone is going on in New York. Laundries and families are using it to wash and bleach at the same time, *in cold water and without soap.*

While European scientists generally keep their discoveries in the inaccessible spheres of high sciences, American chemists bring theirs down to popular utilization and benefits. This practical and sensible method is receiving a new application by chlorozone, which is making its way in industries and households of all classes of America, by turning it into individual uses. It washes clothes faster and cheaper than any soap known, and acts most beneficially as a disinfectant and purifier of the atmosphere in houses, without the inconvenience of an offensive smell, as carbolic acid or lime.

There are several methods of forming ozone; one of the easiest consists in transmitting a succession of electric sparks into dry oxygen. It is so produced in Europe for medical uses, especially in cases of epidemic diseases, cholera, malarial fever, and other affections produced by ifoulness of the air. It has been observed that yellow fever is due to an insufficiency of ozone in the atmosphere during the fermenting heat of summer. Therefore, factories and houses may be sanitarily benefited by the use of chlorozone.

The great difficulty of producing ozone in a tangible and cheap form has been removed by the patented process on which is based the manufacture of chlorozone. The principle of this production at a cheap cost rests on the fact that the ozone of nature has a great affinity with certain oxygenated gas. This being generated in combination with a current of air, the ozone is absorbed and incorporated in a prepared solution, which keeps it stable until it comes in contact with any vegetable material, on which it precipitates with an extraordinary energy. This remarkable scientific fact is accomplished through a perfect but complicated system of generators, retorts, purifiers, and condensers, working successfully in New York after long and expensive studies, besides the price of $30,000 paid for the original patent.—*Textile Colorist.*

DETECTION OF INKS.*

By W. THOMSON, F.R.S.E.

SELDOM is it supposed that a common substance such as the ink used in writing a letter or document has any special individuality about it. All ordinary inks are black, or nearly so, yet it is conceivable that the name and address of the writer of an anonymous letter may, under a given combination of circumstances, be contained within the black fluid with which the letter was written. Some years ago the information obtainable by the examination of the ink on papers or documents would probably have been comparatively insignificant, owing to the fact that the number of different kinds of ink in the market at that time would be small, and the modes of preparation of the ink simple, and the materials used not specially subject to variation. At the present day, however, a large number of different articles, many of which are subject to variation, are employed in the manufacture of ink, and a large number of different inks are in general use; and from these reasons the testimony capable of being obtained by the chemical examination of the ink on letters or documents at the present time may, in some cases, prove to be of the greatest importance.

The reagents which I have found to act best in the testing of the ink on papers are nine, viz.:

1. Dilute sulphuric acid.
2. Strong hydrochloric acid.
3. Slightly diluted nitric acid
4. Sulphurous acid.
5. Caustic soda solution.
6. Cold saturated solution of oxalic acid.
7. Solution of bleaching powder.
8. Solution of protochloride of tin.
9. Solution of perchloride of tin.

The method which I have adopted in applying these reagents is to moisten one or more strokes or letters of the writing with each reagent, and then to absorb by blotting-paper the excess of fluid a few seconds afterwards.

By thus treating the ink on different envelopes lately sent to me, I find they give very diverse results: with sulphuric acid, for instance, the black colors of the different inks are changed, in some to bright crimson, in others to deep red, while some become blue, green, violet, and gray of different shades, and some remain practically unaltered; and when, as sometimes happens, the same, or nearly the same, colors are produced in two different inks by one reagent, the colors produced by another are very different, thus showing clearly that the letters were not written by the same inks.

The same kind of ink, sold by the same maker, but made at different times, also varies more or less in its behavior with the reagents, as shown by the comparisons of three samples of Lyon's ink, sold in small penny bottles, which were bought at different places.

Differences between inks which give nearly the same reactions may sometimes be observed by noticing the lengths of time which the reagents require to bring about the ultimate changes, and by the shades of color through which the ink passes after applying each reagent. Changes also continue to go on gradually for days and weeks after the reagents have been applied. The colors and shades of the same color can be much more distinctly seen by the aid of a good pocket lens.

It is evident that if two persons use ink made by the same maker, at the same time, the reactions would be precisely similar; but it is easy to understand that, after such ink has been in use for some time, owing to the different habits of the users, each may acquire a distinct individuality. One, for instance, may have been more exposed to the air or direct sunlight than the other, and some of the direct coloring matters present may thus have been more or less altered or destroyed. One person may have a habit of leaving his steel pen in the fluid, so that some of the iron may be dissolved, thus altering the character of the ink, while the other may not do so, or may employ a quill in writing. Again, some persons may allow their inks to dry up to a certain extent, and then add to them any fluid which may be at hand, such as tea, coffee, wine, beer, water, etc., each of which would alter the character of the writing fluid, while others may use mixtures of two or more different inks in different and characteristic proportions. One can, therefore, understand that many persons may have in their ink bottles fluids which are so peculiar in chemical composition that they may have as much individuality about them, when treated with reagents, as the faces of their owners. I have tested the same ink on different kinds of paper, and the resulting shades of color produced were identical in each case.

To make use of this mode of investigation it would be necessary to get the ink or inks used by a suspected person, or preferably some writing made by him at or about the same time as any letter or document in question, and test the two side by side with each other. The resulting shades of colors may agree precisely, and may thus tell strongly against the suspected person, or they may differ very much, and so point towards exonerating him.

A case lately occurred in which the expert, M. Chabot, was called, and gave evidence to the effect that the handwriting in a certain libelous letter was that of the person who was indicted as the writer of it. As a witness for the defense another person came forward and swore that he was the writer of the letter in question, and on that evidence the case was dismissed. One can, however, under some circumstances, understand that a suspicion of such a witness having perjured himself may be justifiable, and such a suspicion may possibly be removed from an innocent person by his producing for chemical examination a paper written about the same time and with the same ink as that said to have been used in writing the letter in question.

I have arranged on two sheets of paper the writings on envelopes of fifty different persons lately sent to me. One sheet contains twenty-four, written in Manchester and the suburbs, and the other contains twenty-six, from London and the provinces; and from a minute inspection of these it will be observed that most of them are very different from each other, while no two give exactly similar shades of color with all the different reagents.

* Read before the Manchester Philosophical Society

AN ECONOMICAL PROCESS FOR TREATING MINERAL AND OTHER SUBSTANCES CONTAINING SMALL QUANTITIES OF PHOSPHATE OF LIME.

By C. H. ALLDRED, F.C.S.

HAVING during the summer been making some investigations upon the decomposition of mineral and other phosphates of lime, the following results may be of interest. In trying nearly all the reagents capable of dissolving $3CaOP_2O_5$ I used a solution of SO_2 in water. This, as is well known, although it readily dissolves an artificially precipitated $3CaOP_2O_5$, does not so easily dissolve a mineral phosphate which is intimately mixed with SiO_2, CaO_2, Fe_2O_3, $CaSO_4$, etc., especially if it is an artificial product which has been heated or fused; and if the solution is warmed to assist decomposition, of course the SO_2 is driven off, and any phosphate of lime which had been taken up is precipitated as a bisulphited phosphate of lime, which remains insoluble, mixed with the material under treatment. Thus SO_2 cannot be practically employed in this manner. To prevent the occurrence of this difficulty I tried the following plan: The material employed was a refuse product containing about 22 per cent of $3CaOP_2O_5$, 12 per cent of Fe_2O_3 and Fe_3O_4, and the remainder consisting of CaO, SiO_2, MgO, etc. This was finely ground, and placed in a small boiler lined with lead, fitted with a hot-water jacket. It was then nearly filled with a saturated solution of SO_2 in water. The boiler was then firmly closed up, and the whole heated until the water in the outer jacket (which was not under pressure) boiled, and kept at this temperature for five or six hours; it was then allowed to cool, and the contents filtered. The filtrate contained a large amount, nearly the whole (but a quantitative experiment was not made), of the $3CaO+P_2O_5$, and only a small amount of iron. The former can be precipitated either by adding CaO, or, better, by boiling, when it is precipitated in a fine white powder as a nearly pure bisulphited phosphate of lime, which has a high value as a fertilizer. In putting this process into practical application it would only be necessary to have two boilers lined with lead or other suitable metal. Into the first (A) is charged the phosphatic material, and the solution of SO_2 then heated, but by means of a water-jacket, up to 100° C., when there will be a pressure of about 20 to 30 lb. per square inch. After being kept at this temperature for, say, six hours, a tap is opened near the bottom, connected with a pipe, which leads to the boiler, B, which should be placed on a lower level than A. When this is filled with the liquor it is boiled, the expelled SO_2 being led off from an escape pipe, which will conduct the gas into cold water, where it may be re-absorbed, and the solution be used for the treatment of a fresh batch of raw material. The liquor and precipitated bisulphited phosphate of lime in the boiler B can be run off into settling tanks, when the phosphate can be filtered, pressed, and dried. In this process the SO_2 would to a great extent be recovered, the only loss being that combined with the phosphate of lime and the loss from leakage. To make up these losses, for the supply of SO_2 I propose preparing it from pyrites, sulphur, or H_2SO_4 and coke.

The adoption of this process offers an economical means of treating many substances containing $3CaO,P_2O_5$ in quantities too small to pay for treatment by acids, and especially for localities where large deposits of phosphates occur, but too poor to pay for transit in their natural state. —*Chemical News.*

ON THE LIQUEFACTION OF OZONE, AND ON ITS COLOR IN THE GASEOUS STATE.

By MM. P. HAUTEFEUILLE and J. CHAPPUIS.

OZONE, as commonly prepared, possesses in oxygen so small a tension, 53 mm. at most, that its physical properties are scarcely known and distinguished from those of oxygen. We know the difficulties which M. Soret has so skillfully overcome in determining the density of ozone by operating upon oxygen slightly ozonized.

Among the physical constants of this body its formation-heat has been accurately determined by M. Berthelot, notwithstanding the degree of dilution in which it occurs when issuing from the effluve apparatus. The preparation of a mixture very rich in ozone is the first condition to be fulfilled in order to acquire new notions concerning this curious substance. We have formerly established that the isomeric transformation of oxygen submitted to the electric effluve follows simple laws, and that the proportion of ozone increases very little with the pressure for each temperature, while it is quintupled in passing from 20° to —55°. If withdrawn from the action of the electric discharges the mixture of ozone and oxygen ceases to be a homogeneous system in equilibrium. Nevertheless the mixture remains without appreciable alteration during the whole time that a constant temperature is maintained, operating below 0°. This relative stability of ozone has enabled us to compress the mixture, and to obtain tensions of ozone of several atmospheres.

As it is necessary to prepare the ozone designed for these experiments at the highest tension possible, oxygen must be ozonized at a very low temperature. Consequently it is kept for a quarter of an hour in an apparatus for alternative discharges, the slender concentric glass tubes of which are plunged in methyl-chloride; then it is caused to pass into the cylinder terminated by a capillary tube of Cailletet's apparatus. This reservoir, of about 60 c.c. capacity, originally a vacuum, and kept at —23°, cannot be filled at once under a pressure bordering upon 760 mm., and is rapidly connected 5 times in succession with the effluve apparatus, the capacity of which cannot exceed 20 c.c. In an hour and a quarter we succeed by this means in filling the cylinder with a mixture of oxygen and ozone very rich in the latter gas.

The cylinder is then taken out of the methyl-chloride, and separated from the effluve apparatus by a stroke of the file; the gas which it contains is slowly driven back by means of mercury cooled down to 0° into the capillary tube, which is kept at —23°.

The mercury which transmits the action of the hydraulic press does not impoverish the gaseous mixture as rapidly as might be apprehended; there is formed on the surface of the metal a solid varnish, which rapidly limits the action; the heating of the gas during compression is more to be feared. Notwithstanding these difficulties we succeed in increasing the tension of the ozone in a very high proportion. From the first strokes of the piston the capillary tube becomes a sky-blue. This coloration becomes more marked in proportion as the volume of the gas is reduced, and if the tension of the gas is brought by compression to several atmospheres the gas is an indigo blue, and the meniscus of mercury, seen through the gas, a steel blue. The blue color of the gas becomes less intense, and the mercury resumes its ordinary metallic aspect when the tension of the ozone is diminished.

The above mixture contains enough ozone to permit the observation of a dense white mist at the moment of release after a compression of 75 atmospheres. It is therefore not necessary to compress ozonized oxygen as much as pure oxygen (300 atmos.), in order that a sudden release may occasion the momentary formation of a mist, the certain sign of liquefaction or even solidification. A comparative study of mixtures of oxygen and ozone, and of oxygen and carbonic acid, shows that under conditions which are fairly comparable the release must be stronger for ozone than for carbonic acid in order to make a mist appear. Ozone is therefore a little less easily liquefied than carbonic acid.

The mixture of oxygen and ozone, being an explosive gas, should always be compressed slowly and refrigerated. If these conditions are not observed the ozone is decomposed with the liberation of heat and light, and there is a strong detonation attended with a yellowish flash. M. Berthelot has shown that the transformation of oxygen into ozone absorbs 14·8 cals. per equivalent (O_3=24 grms.). Ozone therefore ranks among the explosive gases, and our experiments show that like them it is capable of a sudden decomposition. A part of these new facts may also be observed in oxygen which has been passed slowly at common temperatures through an effluve apparatus. For if the gas is rapidly compressed in a capillary tube placed in water at 25° the ozone is often destroyed with explosion. But if the same gas is cooled down to —23° the ozone which it contains may be brought to a tension of 10 atmospheres, and may be preserved for hours under these conditions of pressure and temperature if the gas is separated from the mercury by a column of sulphuric acid. We observe them almost as distinctly as in the former experiment, which is more difficult to perform, that ozone is a gas of a beautiful sky-blue. Its color at a tenfold density is so intense that we have been able to see it in a tube of 0·001 meter in diameter when operating in a very badly lighted room of the laboratory of the Ecole Normale.

It is therefore ascertained that under a strong pressure ozone is a colored gas, but is it the same with ozone at the tension of a few millimeters? The blue color is as characteristic of ozone as its odor, for at all tensions it is recognized on examining a stratum of the gas of sufficient depth. In order to render it apparent it is merely needful to interpose between the eye and a white surface a tube of 1 meter long traversed by the current of oxygen which has passed through Berthelot's effluve apparatus. The color of the gas then resembles that of the sky, and is deeper or lighter according as the oxygen has remained a longer or shorter time in the apparatus, and is consequently more or less rich in ozone. As soon as the effluve is interrupted the blue color

disappears, the ozonized oxygen being replaced by pure oxygen.—*Comptes Rendus.*

[The authors add in a note that in a future communication they will make known the part which this colored gas may play in the atmosphere, and what may be its effects upon the different radiations.]—*Chemical News.*

FREEZING MIXTURES FORMED BY AN ACID AND A HYDRATED SALT.

By BERTHELOT.

THE author agrees, on the whole, with Ditte, but points out that in the case of hydrochloric acid and sodium sulphate the maximum thermal effect would correspond with the formation of sodium-hydrogen sulphate and not sulphuric acid. Hydrated sodium sulphate may be regarded as a system in equilibrium composed of the true hydrate, a certain quantity of the anhydrous salt, and free water. When brought in contact with a substance capable of acting on it, such as hydrochloric acid, the latter will first attack the anhydrous sulphate, since no work is required to separate it from combined water. The removal of the small quantity of the anhydrous salt destroys the equilibrium of the system, a fresh quantity is produced, this is immediately acted on by the acid, and so on until the decomposition is complete, since none of the new products bring about special conditions of equilibrium tending to limit the reaction. The liberated water assumes the liquid condition, thus causing an absorption of heat. In the case of equivalent quantities of hydrochloric acid and sodium sulphate, the end products of the reaction cannot be simply sulphuric acid and sodium chloride, for these two substances react together, forming sodium hydrogen sulphate and hydrochloric acid, corresponding with the maximum thermal effect; and, if there were no decomposition of the products, the reaction would cease, whatever the excess of hydrochloric acid. But the presence of the solvent modifies the reaction, the sodium-hydrogen sulphate is partially decomposed, and a system is formed composed of this salt, the normal sulphate, free sulphuric acid, and water. The sodium chloride produced causes further complications, and the final result is a system composed of water, hydrochloric and sulphuric acids, sodium chloride and sulphate, and sodium-hydrogen sulphate. This system remains in equilibrium under certain limited conditions only. If excess of hydrochloric acid is present, the sodium chloride is thrown out of solution and the equilibrium of the system is destroyed; the anhydrous sulphate is acted on by the hydrochloric acid, more sodium chloride is produced, this is at once thrown out of solution, and so on. The whole of the sodium chloride, is, however, only precipitated and the decomposition thus rendered complete, when the excess of hydrochloric acid added is such that, with the water set free, it forms a hydrate of the composition $2HCl.13-16H_2O$, in which the salt is almost totally insoluble. This explanation holds equally well for the reaction of other acids with other hydrated salts. In all these cases there is first an exothermic action, in accordance with the principle of maximum work. The changes which cause an absorption of heat are dissociation of the hydrated salt; disaggregation by the solvent; solution, which in certain cases plays only an intermediate part; and the liquefaction of the liberated water.—*Compt. Rend.*

ON OSTRICH FEATHER DYEING.

By PAUL ALEX, Practical Feather Dyer.

WHEN acid is called for to assist in the production of a *garnet*, the feathers should never be dried up until all the acid is rinsed out of the fiber. It is quite unnecessary to use acid except in a case where you get your feathers accidentally darker than your sample, in which unfortunate event it is the not uncommon custom with many dyers to dissolve some acid (either sulphuric or oxalic) in their starch water, passing their feathers through it until they have acquired the desired shade. If the feathers were to remain concealed from the sun and light, instead of having to be worn and exposed to both, that process for obtaining the desired shade would be found to answer very well. But the color is exposed only a few hours when the acid begins to leave the fiber, and in a few days the color, which, when leaving the bath, a really bright shade of garnet, will, under those circumstances, assume a washy, smoky color. The best method of treatment, in case of the garnet turning out too dark for the sample, is to thoroughly rinse off all the loose color, and then mix a bath of strong sulphuric acid—say, one part acid to thirty parts water—at a tolerably high temperature. Allow the feathers to remain in the bath until they have changed to a Bismarck brown. Take them out and thoroughly rinse them; at the same time being very particular as to the rinsing, because the very smallest amount of acid will ruin your bath. After having extracted the color from your feathers mix a fresh bath, making use of your judgment with reference to the shade you have to match. And here let me remark, before going further, that judgment in the mixing of colors is the one thing wanted; for without good judgment it is wholly impossible to become a good, capable dyer; and although I am fully aware that I have made this same remark before, so emphatically true is it that I feel that I cannot say it too often. I certainly know of no trade that calls for more judgment than that of the dyer. A dyer may have in his possession a thousand recipes, yet without practical knowledge they are wholly useless to him. Let me take an instance. Mix a garment bath, or one of any mordant whatsoever, and enter one pound of Egyptian bronze, also one pound flat bronze, and one pound of gray Egyptian plumes, also one pound of white Cape goods. I allow them all to enter one bath, and let them remain in it for a quarter or half an hour, or even unto such time as the bath is cold. After drying them up I find the result to be as follows: The Egyptian bronze is about four or five shades darker than the flat bronze; the Egyptian gray plumes are about three shades lighter than the Cape plumes; in fact, there are four very distinct shades, all dyed in the one bath. A practical dyer will at once understand how to prepare his feathers for the bath, so that they will all turn out alike. It frequently happens in stores where a large stock is carried that there are numerous colors to be changed each season, such, for instance, as making bottle green to navy blue, seal brown, garnet, or any other dark colors. It is always well to extract as much of the old color as possible before proceeding to put in the new; but in changing browns, greens, blues, or any dark colors to blacks, it is unnecessary to extract any of the color, with the exception of dark reds, in which case extract all the oil color possible. In every case where acid is used to extract with, be sure to have the fibers and also the quill free from acid.

It may be necessary, after your feathers being submerged for awhile in acid, to use hot water for rinsing; if so, use it, and before entering in the bath allow them to remain submerged for about a quarter of an hour in either boiling water or water heated to a high temperature.—*Textile Colorist.*

FAST RED ON COTTON WITH ARTIFICIAL ALIZARINE.

By M. MOYRET.

(22 lb.)

BOIL the yarn in soda lye at 4° Tw.; wash and dry in the air.

Pass into a beck containing 24¼ oz. of alizarine oil in 26 pints of water at 122° Fah.; wring and dry in heat.

Mordant with red liquor 10½ pints at 8¼° Tw.; dry in heat and age for 24 hours.

Dung with 11 lb. cow dung and 2 lb. 3 oz. chalk in 44 pints of water at 150° Fah.; wash thoroughly and wring.

Prepare a dye bath as follows:

A.—Hot water	350 pints.
B.—Acetic acid	7 oz.
C.—Turkey-red oil	3 lb. 7 oz.
D.—Water into which has been squeezed the juice of 6 lb. 9 oz. bran after being boiled for an hour	17½ pints.
E.—Alizarine for red	37½ oz.

Enter cold, work for an hour, raise very slowly to a boil in an hour and a quarter, boil for three-quarters of an hour, lift, drain till morning, wash, wring, and dry.

Pass into a beck containing

Turkey-red oil	24¼ oz.
Water at 95° Fah.	26 pints.

Wring and steam for an hour at a pressure of one atmosphere.

Brighten in a closed boiler with

Soap	8¾ lb.
Soda crystals	2 lb. 3 oz.
Tin crystals	7 oz.

Wash and dry in the air.—*Textile de Lyon.*

CHEMICAL CAUSE OF THE POISONOUS NATURE OF ARSENIC.

LIEBIG proposed a theory of the chemical action of arsenic as a poison, viz., that arsenious acid formed solid compounds with the albumen of living tissues, so preventing its necessary transformations. This view, however, has had to be given up. Another, largely supported by experimental evidence both from without and from within the living organism, has been proposed by two German physiologists—MM. Binz and Schultz. They show that the two states of oxidation of arsenic—viz., arsenious acid and arsenic acid—are rapidly and frequently transformed into each other under the influence of the albumen in the glands of the intestinal canal, which is the part most affected. These reciprocal transformations involve, in the molecule of living albumen where they occur, a violent oscillation of the oxygen atom, in consequence of which the tissues are corroded and completely destroyed. Those portions of the organism which are not affected by the poison during life (or are only secondarily affected) are incapable of effecting the oxidation of arsenious acid. An exact parallel, as regards the nature of poisonous action, occurs between arsenic and nitrogen. Nitric acid is very poisonous. It is changed, by addition of oxygen, into hyponitric acid. This strong caustic destroys the tissues, while returning in part to the state of nitric acid. The nitrogen throughout has no direct action; it is simply the inert vehicle and distributer of the atoms of active and aggressive oxygen. Arsenic fulfills the same functions, being a vehicle for the active oxygen, whenever the arsenious acid is converted into arsenic acid, and the latter returns to the state of arsenious acid.

CERTAIN PROPERTIES OF FLAMES.

By M. MEYRENEUF.

A FLAME produces upon the jet that feeds it two contrary effects, which in general do not compensate each other. It occasions an afflux of gas by the current of expanded products which rise above it, and at the same time a repulsion from the expansion due to the combustion. Either of these effects may be made to predominate by modifying the size of the orifice. Repulsion predominates in flames of distinctly conical outline and afflux in cylindrical flames.

A NEW PROCESS FOR PRODUCING MALLEABLE NICKEL OF DIFFERENT DEGREES OF HARDNESS.

By J. GARNIER.

MELTED nickel is rendered brittle by holding a larger or smaller quantity of oxygen in solution. The author succeeds in removing this oxygen by the addition of phosphorus. Nickel containing not more than 3-1000ths of phosphorus is soft and malleable, but above this dose its hardness increases at the expense of its malleability. One method used by the author for incorporating the phosphorus consists in adding to the melted metal in suitable proportion a nickel phosphide, obtained by melting together a mixture of calcium phosphate, silica, coke, and nickel.

A METHOD OF DETERMINING THE TOPOGRAPHY OF CHEMICAL PROCESSES IN THE ANIMAL SYSTEM.

By W. KOCHS.

SMALL quantities of hippuric acid were formed on digesting blood along with sodium benzoate and glycocol for some hours at 35° to 40° with finely cut kidney. The question was then whether this synthesis depended on the vitality of the cells. Portions of kidney were therefore exposed for two hours to a temperature of —20°. When they were again thawed and comminuted the synthesis could no longer be effected. No hippuric acid was formed if the blood was digested with sodium benzoate and glycocol without kidney. Nor could the synthesis be effected with portions of liver.—*Pflüger's Archiv.*

ALCOHOL IN ANIMAL TISSUES.

By J. BECHAMP.

ALCOHOL and acetic acid are constant and necessary products of putrefaction. The author has also discovered alcohol in small quantities in normal and quite recent animal tissues, a fact which should be remembered in chemico-judicial investigations.—*Ann. Chim. Phys.*

IGNEOUS ROCKS.

Address to the Geological Section of the British Association, 1880. By H. CLIFTON SORBY, LL.D., F.R.S., F.G.S., President of the Section.

IN selecting a subject for an address to be given in accordance with the custom of my predecessors, I was anxious that it should be, in some way or other, connected with the locality in which we have met. If I had been adequately acquainted with the district I should have thought it incumbent on me to give such an outline of the general geology of the surrounding country as would have been useful to those attending this meeting. I am, however, practically a stranger to South Wales, and must, therefore, leave that task to others. On reflecting on the various subjects to which I might have called your attention, it appeared to me that I could select one which would be eminently appropriate in a town and district where iron and copper are smelted on so large a scale, and, as I think, also equally appropriate from a geological point of view. This subject is the comparative structure of artificial slags and erupted rocks. In making this choice I was also influenced by the fact that in my two anniversary addresses as president of the Geological Society I have recently treated on the structure and origin of modern and ancient stratified rocks, and I felt that, if in the present address I were to treat on certain peculiarities in the structure of igneous rocks, I should have described the leading conclusions to which I have been led by studying the microscopical structure of nearly all classes of rocks. It would, however, be impossible in the time now at disposal to treat on all the various branches of the subject. Much might be said on both the purely chemical and purely mineralogical aspects of the question; but though these must not be ignored, I propose to draw your attention mainly to another special and remarkable class of facts, which, so far as I am aware, have attracted little or no attention, and yet, as I think, would be very instructive if we could fully understand their meaning. Here, however, as in so many cases, the observed facts are clear enough, but their full significance somewhat obscure, owing to the want of adequate experimental data or sufficient knowledge of general physical laws.

A considerable amount of attention has already been paid to the mineral constitution of slags, and to such peculiarities of structure as can be learned independently of thin microscopical sections. A very complete and instructive work, specially devoted to the subject, was published by Von Leonhard about twenty-two years ago, just at the time when the microscope was first efficiently applied to the study of rocks. Since then Vogelsang and others have described the microscopical structure of some slags in connection with their studies of obsidian and other allied volcanic rocks. At the date of the publication of Von Leonhard's work the questions in discussion differed materially from those which should now claim attention. There was still more or less dispute respecting the nature and origin of certain rocks which have now been proved to be truly volcanic by most unequivocal evidence; and I am not all surprised at this, since, as I shall show, there is such a very great difference in their characteristic structure and that of the artificial products of igneous fusion, that, but for the small portions of glass inclosed in the constituent crystals, described by me many years ago under the name of "glass cavities," there would often be no positive proof of their igneous origin. There was also considerable doubt as to the manner in which certain minerals in volcanic rocks had been generated. The observed facts were sufficient to prove conclusively that some had been formed by sublimation, others by igneous fusion, and others deposited from more or less highly heated water; but it was difficult or impossible to decide whether in particular cases certain minerals had been formed exclusively by one or other processes, or sometimes by one and sometimes by the other, or by the combined action of water and a very high temperature. I must confess that, even now that so much may be learned by studying with high magnifying powers the internal structure of crystals, I should hesitate very much in deciding what were the exact conditions under which certain minerals have been formed. This hesitation is probably as much due to inadequate examination and to the want of a complete study of typical specimens, both in the field and by means of the microscope, as to the unavoidable difficulties of the subject. Such doubt, however, applies more to the origin of minerals occurring in cavities than to those constituting a part of true rock masses, to which latter I shall almost exclusively refer on the present occasion. In the formation of these it appears to me that sublimation has occurred to a very limited extent. In many cases true igneous fusion has played such a leading part that the rocks may be fairly called *igneous*, but in other cases, water, in some form or other, has, I think, had so much influence that we should hesitate to call them *igneous*, and the term *erupted* would be open to far less objection, since it would adequately express the manner of their occurrence, and not commit us to anything open to serious doubt.

In studying erupted rocks of different characters, we see that at one extreme they are as truly igneous as any furnace product, and, at the other extreme, hardly, if at all, distinguishable from certain deposits met with in mineral veins, which furnish abundant evidence of the preponderating, if not exclusive, influence of water, and have very little or nothing in common with products certainly known to have been formed by the action of heat, and of heat alone. Between these extremes there is every connecting link, and in certain cases it is almost, if not quite, impossible to say whether the characteristic structure is due more to the action of heat than of water. The great question is whether the presence of a small quantity of water in the liquid or gaseous state is the true cause of very well marked differences in structure; or whether greater pressure, and the necessarily slow rate of cooling, were not the more active causes, and the presence of of water in one state or another was merely the result of the same cause. This is a question which ought to be solved by experiment; but I fear it will be almost impossible to perform the necessary operations in a satisfactory manner.

What I now propose to do is to describe a particular class of facts which have lately attracted my attention, and to show that the crystalline minerals in products known to have been formed by the action of heat alone have a certain very well-marked and characteristic structure, which is gradually modified as we pass through modern and more ancient volcanic to plutonic rocks, in such a manner as to show at once that they are intimately related, and yet differ in such characteristic particulars that I think other agencies than mere heat must have had great influence in producing the final result.

In dealing with this subject I propose, in the first place, to describe the characteristic structure of products formed

artificially under perfectly well-known conditions, and then to pass gradually to that of rocks whose origin must be inferred and cannot be said to have been completely proved.

CRYSTALLINE BLOWPIPE BEADS.

Some years ago I devoted a considerable amount of time to the preparation and study of crystalline blowpipe beads, my aim being to discover simple and satisfactory means for identifying small quantities of different earths and metallic oxides, when mixed with others; and I never supposed that small objects would throw any light on the structure and origin of vast masses of natural rock. The manner in which I prepared them was as follows:

A small bead of borax was so saturated with the substance under examination at a high temperature that it became opaque either on cooling or when slowly re-heated. It was again fused so as to be quite transparent, and then very slowly cooled over the flame. If properly managed, the excess of material held in solution at a high temperature slowly crystallized out, the form and character of the crystals depending on the nature of the substance and on the presence of other substances added to the bead as test reagents. By this means I proved that in a few exceptional cases small simple solid crystals are formed. More frequently they are compound, or occur as minute needles; but the most characteristic peculiarity is the development of complex skeleton crystals of extreme beauty, built up of minute attached prisms, so as to give rise to what would be a well-developed crystal with definite external planes, if the interspaces were all filled up. In many cases the fibers of these skeletons are parallel to three different axes perpendicular to one another, and it might be supposed that the entire skeleton was due to the growth of small needle-shaped crystals all uniformly elongated in the line of one crystalline axis, so that the resulting mass would be optically and crystographically complex; but in some cases the different systems of fibers or needles are inclined obliquely, and then the optical characters enable us to prove that the separate prisms are not similar to one another, but developed along different crystalline planes, so as to build up one definite crystal, mechanically complex, but optically and crystographically simple, or merely twinned. In a few special cases there is a well-pronounced departure from this rule, and truly compound groups of prisms are formed. In the center, that is a definite simple prism; but instead of this growing continuously in the same manner, so as to produce a larger prism, its ends, as it were, break up into several smaller prisms, slightly inclined to the axis of the first; and these secondary prisms, in like manner, break up into still smaller, so as ultimately to give rise to a curious complex brush-like growth, showing in all positions a sort of fan-shaped structure, mechanically, optically, and crystographically complex.

I have done my best to describe these various kinds of crystals seen in blowpipe beads as clearly as can be done without occupying too much time, but feel that it is impossible to make the subject as simple as it really is without numerous illustrations. However, for the purpose now in view, it will, I trust, suffice to have established the fact that we may divide the crystals in blowpipe beads into the following groups, which on the whole are sufficiently distinct, though they necessarily pass one into the other.

1. Simple crystals.
2. Minute detached needles.
3. Fan-shaped compound groups.
4. Feathery skeleton crystals.

It must not be supposed that crystals of one or other of these groups occur promiscuously and without some definite relation to the special conditions of the case. Very much depends upon their chemical composition. Some substances yield almost exclusively those of one group, and other substances those of another, while in some cases a difference in the rate of cooling and other circumstances give rise to variations within certain limits; and, if it were possible to still further vary some of the conditions, these limits would probably be increased. Thus, for example, the earliest deposition of crystalline matter from the glassy solvent is sometimes in the form of simple solid prisms or needles, but later on in the process it is in the form of compound feathery tufts; and if it were possible to cool the beads much more slowly while they are very hot, I am inclined to believe that some substances might be found that in the early stage of the process would yield larger and more solid crystals than those commonly met with. This supposition, at all events, agrees with what takes place when such salts as potassium chloride are crystallized from solution in water. Some of my blowpipe beads prove most conclusively that several perfectly distinct crystalline substances may be contemporaneously deposited from a highly heated vitreous solvent, which is an important fact in connection with the structure of igneous rocks, since some authors have asserted that more than one mineral species cannot be formed by the slow cooling of a truly melted rock. The great advantage of studying artificial blowpipe beads is that we can so easily obtain a variety of results under conditions which are perfectly well known and more or less completely under control.

ARTIFICIAL SLAGS.

I now proceed to consider the structure of slags, and feel tempted to enter into the consideration of the various minerals found in them which are more or less perfectly identical with those characteristic of erupted rocks; but some of the most interesting, like the feldspars, occur in a well-marked form only in special cases where iron ores are smelted with fluxes, seldom, if ever, employed in our own country, so that my acquaintance with them is extremely small. My attention has been mainly directed to the more common products of our blast furnaces. On examining these, after having become perfectly familiar with the structure of blowpipe beads, I could see at once that they are very analogous, if not identical, in their structure. In both we have a glassy solvent, from which crystals have been deposited; only in one case this solvent was red hot, melted borax, and in the other glassy, melted stone.

Thus, for example, some compounds, like what I believe is Humboldtilite, crystallize out in well-marked solid crystals, like those seen occasionally in blowpipe beads, whereas others crystallize out in complex feathery skeletons, just like those so common in and characteristic of the beads. In both we also often see small detached needles scattered about in the glassy base. These skeleton crystals and minute needles have been described by various writers under the names *crystallites*, *belonites*, and *trichites*. Though we have not the great variety of different forms met with in the beads, and cannot so readily vary the conditions under which they are produced, yet we can, at all events, see clearly that their structural character depends both on their chemical constitution and on the physical conditions under which they have crystallized. None of my microscopial preparations of English slags appear to contain any species of feldspar, but several contain what I believe is some variety of angite, both in the form of more or less solid prisms, and of feathery skeletons of great beauty and of much interest in connection with the next class of products to which I shall call your attention, viz., rocks artificially melted and slowly cooled.

ROCKS ARTIFICIALLY MELTED.

I have had the opportunity of preparing excellent thin microscopical sections of some of the results of the classic experiments of Sir James Hall. I have also carefully studied the product obtained by fusing and slowly cooling much larger masses of the basalt of Rowley, and have compared its structure with that of the original rock. Both are entirely crystalline, and, as far as I can ascertain, both are mainly composed of the same minerals. Those to which I would especially call attention are a triclinic feldspar and the angite. The general character of the crystals is, however, strikingly different. In the artificial product a considerable part of the angite occurs as flat feathery plates, like those in furnace slags, which are quite absent from the natural rock, and only part occurs as simple solid crystals, analogous to those in the rock, but much smaller and less developed. The feldspar is chiefly in the form of elongated, flat, twinned prisms, which like the prisms in some blowpipe beads, commence in a more simple form and end in complex fan-shaped brushes, whereas in the natural rock they are larger than in the artificial, and exclusively of simple character. On the whole, then, though the artificially melted and slowly cooled basalt is entirely crystalline, and has a mineral composition closely like that of the natural rock, its mechanical structure is very different, being identical with that of blowpipe beads and slags.

VOLCANIC ROCKS.

Passing now to true natural igneous rocks, we find some, like obsidian, which closely correspond with blowpipe beads, slags, and artificially melted rocks, in having a glassy base, through which small crystalline needles are scattered; but the more completely crystalline volcanic rocks have, on the whole, a structure very characteristically unlike that of the artificial products. I have most carefully examined all my sections of modern and ancient volcanic rocks, but cannot find any in which the angite or magnetite is crystallized in feathery skeletons. In the case of only one single natural rock, from a dike near Beaumaris, have I found the triclinic feldspar arranged in just the same fan-shaped, brush-like groups as those in similar rocks artificially melted and slowly cooled. The large solid crystals in specimens from other localities sometimes show that toward the end of their growth small flat prisms were developed on their surface, analogous to those first deposited in the case of the artificial product. In slags composed almost exclusively of what I believe is Humboldtilite, the crystals are indeed uniformly as simple as those in natural rocks, but the examination of different blowpipe beads shows that no fair comparison can be made between altogether different substances. We must compare together the minerals common to the natural and the artificial products, and we then see that, on the whole, the two classes are only just distinctly connected by certain exceptional crystals and by structural characters which, as it were, overlap enough to show that there is a passage from one type to the other. In the artificial products are a few small solid crystals of both angite and a triclinic feldspar, which closely correspond to the exceptionally small crystals in the natural rocks; but the development of the great mass of the crystals is in a different direction in the two cases.

In the artificial product it is in the direction of complex skeletons, which are not seen in the natural rock; but in the natural rock it is in the direction of large simple solid crystals, which are not met with in the artificial products. There is a far closer analogy in the case of partially vitreous rocks, wich, independent of the true glassy base common to them and the artificial products, often contain analogous crystalline needles. Even then, however, we see that in the artificial product the crystals tend to develop into complex skeletons, but in the natural rocks into simple solid crystals.

It must not be supposed that these facts in any way lead me to think that thoroughly crystalline modern and ancient volcanic rocks were never truly fused. The simple, large, and characteristic crystals of such minerals as angite, feldspar, leucite, and olivine, often contain so many thoroughly well marked glass inclosures, as to prove most conclusively that when the crystals were formed they were surrounded by, and deposited from, a melted glassy base, which was caught up by them while it was still melted. This included glass has often remained unchanged, even when the main mass became completely crystalline, or has been greatly altered by the subsequent action of water. I contend that these glass inclosures prove that many of our British erupted rocks were of as truly igneous origin as any lava flowing from a modern volcano.

The difference between the structure of such natural rocks and that of artificial slags must not, in my opinion, be attributed to the absence of true igneous fusion, but to some difference in the surrounding conditions, which was sufficient to greatly modify the final result, when the fused mass became crystalline on cooling. The observed facts are clear enough, and several plausible explanations might easily be suggested, but I do not feel at all convinced that any single one would be correct. That which first suggests itself is a much slower cooling of the natural rocks than is possible in the case of the artificial rocks; and I must confess that this explanation seems so plausible that I should not hesitate to adopt it, if certain facts could be accounted for in a satisfactory manner.

Nothing could be more simple than to suppose that skeleton crystals are formed when deposition takes place in a hurried manner, and they so overgrow the supply that they develop themselves along certain lines of growth before there has been time to solidly build up what has been roughly sketched in outline. I cannot but think that this must be a true and to some extent, active cause, even if it be inadequate to explain all the facts. What makes me hesitate to adopt it by itself is the structure of some doleritic rocks when in close contact with the strata among which they have been erupted. In all my specimens the effects of much more rapid cooling are perfectly well marked. The base of the rock when in close contact is sometimes so extremely fine grained that it is scarcely crystallized, and is certainly far less crystalline and finer grained than the artificial products to which I have called attention, and yet there is no passage toward those structures which are most characteristic of slags, or at least, no such passage as I should have expected if these structures depended exclusively on more rapid cooling.

We might well ascribe something to the effect of mass, but one of my specimens of basalt melted and slowly cooled in a small crucible is quite as crystalline as another specimen taken from a far larger mass, though I must confess that what difference there is in this latter is in the direction of the structure characteristic of natural rocks. The presence or absence of water appears to me a very probable explanation of some differences. When there is evidence of its presence in a liquid state during the consolidation of a rock we can scarcely hesitate to conclude that it must have had some active influence; but in the case of true volcanic rocks the presence of liquid water is scarcely probable. That much water is present in some form or other is clearly proved by the great amount of steam given off from erupted lavas. I can scarcely believe that it exists in a liquid state, except at great depths, but it may possibly be present in a combined form or as a dissolved vapor under much less pressure, and the question is whether this water may not have considerable influence on the growth of crystals formed prior to the eruption, before it was given off as steam. I do not know one single fact which can be looked upon as fairly opposed to this supposition, and it is even to some extent supported by experiment. M. Daubrée informs me that the crystals of angite formed by him at a high temperature by the action of water have the solid character of those in volcanic rocks, and not the skeleton structure of those met with in slags. The conditions under which they were formed were, however, not sufficiently like those probably present during the formation of erupted lavas to justify our looking upon the explanation I have suggested as anything more than sufficiently plausible, in the absence of more complete experimental proofs.

GRANITIC ROCKS.

I now proceed to consider rocks of another extreme type, which for distinction we may call the granitic. On the whole, they have little or nothing in common with slags, or with artificial products similar to slags, being composed exclusively of solid crystals, analogous in character only to slag-crystals of very different mineral nature. As an illustration, I would refer to the structure of the products formed by fusing and slowly cooling upwards of a ton of the syenite of Grooby, near Leicester. Different parts of the resulting mass differ very materially, but still there is an intimate relation between them, and a gradual passage from one to the other. The most characteristic feature of those parts which are completely crystalline is the presence of beautiful feathery skeleton crystals of magnetite, and of long flat prisms of a triclinic feldspar, ending in complex, fan-shaped brushes. There are no solid crystals of feldspar, hornblende, and quartz, of which the natural rock is mainly composed, to the entire exclusion of any resembling those in the melted rock. As looked upon from the point of view taken in this address the natural and artificial products have no structural character in common, so that I think we must look for other conditions than pure igneous fusion to explain the greatly modified results. We have not to look far for evidence of a well marked difference in surrounding circumstances.

The quartz in the natural rock contains vast numbers of fluid cavities, thus proving that water was present, either in the liquid state or as a vapor so highly compressed that it afterwards condensed into an almost equal bulk of liquid. In some specimens of granite there is indeed clear proof that the water was present as a liquid, supersaturated with alkaline chloride, like that inclosed in the cavities of some minerals met with in blocks ejected from Vesuvius, which also have to some extent what may be called a granitic structure. In the case of one very exceptional and interesting granite, there is apparently good proof that the feldspar crystallized out at a temperature above the critical point of water —that is to say, at a temperature higher than that at which water can exist as a liquid under any pressure—and it caught up highly compressed steam, comparatively, if not entirely, free from soluble salts; whereas the quartz crystallized when the temperature was so far lowered as to be below the critical point, and the water had passed into a liquid, supersaturated with alkaline chlorides, which have crystallized out as small cubes in the fluid cavities, just as in the case of minerals in some of the blocks ejected from Vesuvius.

Confining our attention, then, to extreme cases, we thus see that rocks of the granitic type differ in a most characteristic manner from the products of artificial igneous fusion, both in the structure of the crystals and in containing liquid water, inclosed at the time of their formation. The question then arises, whether these differences were due to the presence of the liquid water, or whether its presence and the characteristic structure were not both the effects of the great pressure of superincumbent rocks. I do not see how this can be decided in a perfectly satisfactory manner, but must confess that I am inclined to believe that while great pressure was necessarily the reason why the water did not escape as vapor, the presence of liquid water during final consolidation must have had a very considerable influence in modifying the structure of the rock, and had a great share in developing what we may call the granitic type.

It would be very instructive to follow out the gradual passage from one extreme type to another far more completely than is possible on the present occasion. The most interesting examples of rocks intermediate between the granitic and volcanic types that I have been able to examine in adequate detail, are the various Cornish elvans and other quartz felsites, which furnish all but a complete passage from pitchstone to granite. Some specimens prove that quartz may crystallize out from and inclose a perfectly glassy base, without a trace of liquid water; and at the same time other specimens prove equally well that, as we approach the granitic type, the quartz was not deposited from a glassy solvent, but inclosed more or less water. In the few intermediate cases there appears to be evidence of the conjoint presence of uncombined water and melted stony matter. On the whole, if we take into consideration only the external form of the larger crystals, rocks of the granitic type are very much as though the crystals met with in truly volcanic rocks had been strained out from the glasey or fine-grained base, and the intermediate spaces filled with quartz. The internal structure of the crystal is, however, very different, the cavities in one class containing glass and in the other water.

This most essential and characteristic difference proves that rocks of the true granitic type cannot have been formed simply by the more complete crystallization of the general base of the rock. If the crystals in granite were analogous to those developed in volcanic rocks, and the only essential difference were that the residue crystallized out more slowly and completely, so as to give rise to a more coarsely crystallized base, the crystals first formed ought not, as I think, to differ so essentially as that in one case they should inclose only glass, and in the other only water. Taking all into

consideration, we can therefore scarcely suppose that the crystals in granitic rocks were deposited from a truly melted, dry, glassy solvent, like those in volcanic rocks or in slags.

GENERAL RESULTS.

I have, I trust, now said enough to show that the objects here described may be conveniently separated into three well marked groups, viz., artificial slags, volcanic rocks, and granitic rocks. My own specimens all show perfectly well-marked and characteristic structures, though they are connected in some cases by intermediate varieties. Possibly such connecting links may be more pronounced in other specimens that have not come under my notice. I must, however, base my conclusions on what I have been able to study in an adequate manner, by examining my own preparations, and leave it for others to correct any errors into which I have been led from lack of more numerous specimens. In any case the facts seem abundantly sufficient to prove that there must be some active cause for such a common, if not general, difference in the structural character of these three different types. The supposition is so simple and attractive, that I feel very much tempted to suggest that this difference is due to the presence or absence of water as a gas or as a liquid. In the case of slags it is *not* present in *any* form. Considering how large an amount of steam is given off from eruptive lavas, and that, as a rule, no fluid cavities occur in the constituent minerals, it appears to me very plausible to suppose that those structures which are specially characteristic of volcanic rocks are in great measure, if not entirely, due to the presence of *associated* or *dissolved vapor*.

The fluid cavities prove that water was sometimes, if not always, present as a *liquid* during the consolidation of granitic rocks; and we can scarcely hesitate to conclude that it must have had very considerable influence on the rock during consolidation. Still, though these three extreme types appear to be thus characterized by the absence of water, or by its presence in a state of vapor or liquid, I think we are scarcely in a position to say that this difference in the conditions is more than a plausible explanation of the differences in their structure. At the same time, I do not know any facts that are opposed to this conclusion, and we should, perhaps, not greatly err in thus correlating the structures, even though the water was not the essential and active cause of the differences.

Confining our attention to the more important crystalline constituents which are common to the different types, we may say that the chief structural characters of the crystals are as follows:

a. Skeleton crystals.
b. Fan-shaped groups.
c. Glass cavities.
d. Simple crystals.
e. Fluid cavities.

These different structural characters are found combined in different ways in the different natural and artificial products; and for simplicity I will refer to them by means of the affixed letters.

The type of the artificial products of fusion may generally be expressed by $a+b$ or $b+c$, that is to say, it is characterized by skeleton crystals and fan-shaped groups, or by fan-shaped groups and glass cavities. In like manner the volcanic type may be expressed occasionally by $b+c$, but generally by $c+d$; and the granitic by $d+e$. These relations will be more apparent if given in the form of a table, as follows

Slag type	$a+b$, $b+c$
Volcanic type	$b+c$, $c+d$
Granitic type	$d+e$

Hence it will be seen that there is a gradual passage from one type to the other by the disappearance of one character and the appearance of another, certain characters the meanwhile remaining common, so that there is no sudden break, but an overlapping of structural characteristics. It is, I think, satisfactory to find that, when erupted rocks are examined from such a new and independent point of view, the general conclusions to which I had been led are so completely in accord with those arrived at by other methods of study.

CONCLUSION.

And now I feel that it is time to conclude. I have necessarily been compelled to give only a general account of the subject, and perhaps, for want of adequate description, many facts may appear more complex than they really are. Some are, indeed, of anything but simple character, and their full explanation is, perhaps, beyond our present power. The greater part are, however, much more simple and easy to observe than to describe; and, even if I have failed to make everything as plain as I could wish, I hope I have succeeded in making the principal point sufficiently clear to show that the structure of slags and of analogous artificial products throws much light on the structure and origin of the various groups of erupted rocks. I feel that very much still remains to be learned, and, as I think, could be learned, by the further extension of this method of inquiry. What strikes me most is the great necessity for the more complete application of experimental methods of research; but to carry out the experiments necessary to clear up the essential difficulties of the subject would, I fear, be a most difficult undertaking. In the meantime all that we can do is to compare the structure of known artificial products with that of natural rocks, and to draw the best conclusions we can from the facts, as viewed in the light of our present knowledge of chemistry and physics. My own impression is that there is still much to be learned respecting the exact conditions under which some of our commonest rocks were formed.

FIG. 1.—BRAZILIAN GRASSHOPPER. (Natural Size.)

FIG. 2.—BRAZILIAN GRASSHOPPER. (Natural Size.)

PECULIAR INSECTS.

CHARLES DARWIN was the first to call the attention of the scientific world to the fact that the color of animals of one and the same family and class differed in various parts of the earth according to the color of the surroundings of the animal, thus affording the latter a very effective means of avoiding detection and thus protecting itself. The small insects that live in the leaves and herbs are of a bright green, the fishes have a bluish gray color, the polar fox is white like the ice and snow surrounding him, whereas his brother of milder climate is of a reddish brown color, in accordance with the darkness of our forests and woods, and in like manner innumerable examples might be cited. We will now examine a few most striking examples in which the deception is so great that leading scientists have been repeatedly deceived. In the annexed cuts Figs. 1 and 2 represent two Brazilian grasshoppers known as the eyed pterochroza (*Pterochroza ocellata*). In this insect we have a member of the animal kingdom reproducing the forms, colors, and even accidental variations of leaves with the greatest possible accuracy. In this instance the resemblance to leaves is not only due to the peculiar outline and the leaf-like nervures, but to the presence of certain spots which look exactly like the tracks of leaf-mining or leaf-devouring caterpillars.

The upper wings of the pterochroza are of a light green with dark brown spots. It will be noticed that Fig. 2 has a most striking resemblance, which in reality is so great that it is hard to discern it from a withered oak or beech leaf. Upon seeing a photograph of this wonderful insect Charles Darwin remarked: "It seems to be a beautiful case of protective resemblance. In Fig. 3, Indian butterflies known as the *Kallima paralecta*, are represented in flight and at rest. The upper side of the insect is purple, and a broad stripe or band of deep orange extends from one end of the upper wings to the other, giving the insect a most peculiar appearance when the same is in flight. The underside of the insect is of an ashy gray, brown, or yellow shade, and has precisely the same appearance as a withered and dried leaf. The front wings are drawn to a point like the leaves of tropical plants, and the rear wings terminate in a short thin tail. A dark curved line unites the two opposite ends of the wings, and smaller lines project from this central line, as shown in the lower part of the middle of the cut, thus resembling a leaf so closely that it is almost impossible to discern one from the other.

FIG. 3.—INDIAN BUTTERFLIES AT FLIGHT AND AT REST.

IN the first of the series of his Cantor lectures, Robert W. Edis thus concisely states how decoration and furniture of town houses should be treated: "The great aim of the designer should be simplicity and appropriateness of form and design, with harmony of color.

SALMON DISEASE.

THE report of Mr. Frank Buckland, Mr. Spencer Walpole, and Mr. Archibald Young, who were appointed commissioners to inquire into the causes of the salmon disease which has extensively prevailed in the last few years in English and Scotch rivers and the means of curing it, has just been issued. The commissioners report to the effect that the disease is a fungus known to naturalists as the *Saprolegnia ferax*, which multiplies both asexually and bisexually with extraordinary rapidity. The scientific evidence tends to show that the fungus has existed for a lengthened period, but has been only recently stimulated into unusual reproductive energy. The commissioners have been unable to ascertain any one cause for the epidemic character of the recent outbreak. The disease appears to be a fresh water disease, though the commissioners as a body hesitate to say that the *saprolegnia* cannot live in salt water—an opinion, however, strongly held by Mr. Frank Buckland personally. The commissioners see little hope of successfully coping with the disease itself; but a good deal may be done to improve the condition of the fish by improving the condition of the rivers —(1) by facilitating the passage of salmon up and down the rivers; (2) by the prevention of pollutions; and (3), if rivers should be overstocked, by sanctioning the destruction of kelts, or possibly by sanctioning the capture for a certain time of the less valuable salmonidæ after the commencement of the close season. But in every case all dead fish should be removed from the rivers and buried beyond high water mark, or burnt. There is an addendum by Mr. Frank Buckland, which enters elaborately into the various causes to which the disease and its spread have been attributed, viz., 1, pollutions; 2, lowness of water; 3, effects of frost and snow; 4, overcrowding of fish; 5, obstruction by weirs; 6, dead fish left in rivers; 7, wounds from fish fighting and injuries by anglers; and 8, transport of fungus by birds. The report contains a photograph of diseased salmon, and, in appendices, the evidence taken by the Commissioners, and observations by Professor Rolleston, Mr. Erasmus Wilson, and others.

ALBERT J. MYER.

THE young science of meteorology has sustained another heavy loss in the death of General Myer, of the Signal Service of the United States, at Buffalo, New York, on August 24, in the fifty-second year of his age. In 1851 he entered the United States army as an assistant surgeon, was assigned to special duty in the Signal Service in 1858, and in 1860 was made chief signal officer of the army, a position he held till his death.

The distinguished services rendered by General Myer to meteorology may be considered as having been made chiefly during the last ten years. Americans claim for the late Prof. Henry, of the Smithsonian Institution, the honor of having originated, upwards of thirty years ago, the idea of using the telegraph for conveying information regarding coming changes of weather. But it was reserved to General Myer, as respects the United States, to translate the idea into the action of every-day life, in devising, developing, and extending a system of telegrams and reports for the benefit of commerce and agriculture, which, as regards the completeness of its organization, the thoroughness with which it is worked, and its effective success, stands out as a model system of weather telegraphy. Three large weather maps are prepared and issued daily, along with three daily forecasts of the weather, which the telegraph at once sends through all the towns, villages, and hamlets of the States; and no time is lost, on the expiry of each month, in preparing and widely circulating a Weather Review, accompanied with maps showing the storm-tracks, the geographical distribution of the atmospheric pressure, temperature, and rainfall for the month; together with occasional weather-maps for the highest importance in their bearing on the meteorology of America, Europe, and the rest of the northern hemisphere.

The other great service rendered by General Myer, to practical science is the system of international meteorology established by him, one of the important outcomes of which is the series of United States weather-maps now appearing in *Nature*, showing the meteorology of the globe for each month. When the scheme was first proposed to the Meteorological Congress at Vienna, in 1873, it was difficult to regard it in any other light than as an impracticable, if not wholly visionary, proposal; but the feeling quickly changed as General Myer unfolded the details of its practical working, and explained that what he required from his brother meteorologists, in addition to their approval of the scheme, was one daily observation at a selected few of their stations, he being authorized by the American Government to say that they would undertake the expense of collecting and discussing the observations.

As our readers are aware, the scheme in General Myer's hands has been a pre-eminent success; and a body of facts is being thereby amassed, destined to furnish the key to the larger problems of meteorology, a science which, from the complex intricacies it presents, requires more than any other science a whole hemisphere at least as its basis of observation. Perhaps the most important of the practical questions which will thus fall to be dealt with are those abnormal distributions of the mass of the earth's atmosphere, short continued or more permanent, from which arise great storms or devastating tornadoes, excessive heat or cold, fine seasons or their opposites, and long-continued rains or droughts, so terrible for the famines which attend them. The explanation of these anomalies will doubtless be the immediate precursor of an intelligent and practically successful forecasting of the character of coming seasons.

This magnificent work General Myer could not have accomplished unless he had been backed by the moral and material assistance so generously and readily accorded him by his Government. With a settled conviction that this national work, if undertaken by all, should be carried out in a spirit and manner worthy of the great Republic, the Government of the United States relegated the work to the Signal Service of the War Department, with an annual vote from the exchequer, which, while not too large for the work to be done, no Government on this side the Atlantic has yet thought of emulating.

While writing this brief notice of General Myer's work, we have been repeatedly reminded of the name of Lever ier —probably because, though widely different in many ways, both rendered services to meteorology to a great extent identical; both possessed the rare genius of organizing and the resolute will that easily sets obstacles aside; both secured the support of their respective Governments; both were animated by large views of the capabilities and requirements of the science, and both were successful in an eminent degree in largely extending the sphere of its operations.—*Nature.*

DWARFS AND GIANTS.

THE Royal Aquarium at London has had on exhibition for some time a dwarf and a giant, both natives of China, and both remarkable as regards their stature. The giant, who is named Chang, a native of Peking, is especially extraordinary, being eight feet in height. Such a stature is almost unique among the large men whose size has been recorded in scientific works. The dwarf, Che-mah, is only three feet in height—quite a rare stature even in the world of dwarfs.

These two individuals are represented in the accompanying engraving copied from a photograph, and which we take from *La Nature*. The giant is a very intelligent man, and speaks fluently several languages—English, French, German, Spanish, Chinese, and Japanese. A man who is thus capable of speaking different languages is evidently not an imbecile; but in this, Chang offers a marked contrast to those of his kind; since, according to Isidore Geoffroy Saint Hilare, giants are most usually indolent, apathetic, and wanting in intelligence. For instance, the Norwegian giant, Henry Brustad, who also is at London, is very indolent, has a stupid appearance, and says nothing; and his pointed skull looks as if it were deformed. Brustad is nearly eight feet in height, is possessed of great muscular strength, and is thirty-five years old. Chang is two years younger. The presence at London of these three so extraordinary individuals gives us so much the better occasion to refer to the rules observed as to the development of dwarfs and giants which Prof. Taruffi has just published at Milan, in his two memoirs on the anomalies of stature. Prof. Taruffi's work supplies a want of teratological science, since, although observations on giants and dwarfs are not rare, there have been few of

THE CHINESE GIANT CHANG, AND DWARF CHE-MAH, AT THE LONDON AQUARIUM.
(From Photographs.)

them that were well made, and in which have been noted the length of the different parts of the body in order to ascertain which are the ones that contribute most to increase or diminish the stature of these exceptional beings. The author, from careful measurements, concludes that, as far as giants are concerned, the femur contributes especially to the elongation of their body; but that, on the contrary, their vertebral column is short in proportion to their enormous height. The humerus is notably elongated, but less so than the femur. Their feet and hands increase proportionally with their height. In general terms it might be said that the longer the bones in the normal individual, the more elongated they are in giants. The skull of giants is ordinarily small with respect to their height; but it is enormous in absolute measurement, although the intelligence is generally not well developed. For example, we may mention the giant "Joachim" (6·9 feet in height) observed by M. Broca. This Hercules, who was a perfect realization of the saying, "big, strong, and brutish," made his living by exhibiting himself—a social function which he still exercises in death, since he is exhibited in the museum of the Anthropological Society (now known as the Broca Museum). This man was so stupid that his friends said of him that he had just enough wits to gain his livelihood—which, however, was not difficult. This immense imbecile had a colossal skull measuring 1,950 cubic centimeters, and his brain weighed 1,735 grammes, or almost as much as that of Cuvier! This fact shows plainly that intelligence is not the only factor of brain weight, but that stature and weight have a great influence on this result. The observations collected together by Prof. Taruffi relative to dwarfs are too few to be conclusive. It must be admitted, however, that the femur—the bone which is most elongated in giants, is also the one which in dwarfs decreases the most in proportion to the stature. The shin bone decreases much less in them, and it is often as long as the thigh bone. The head of the dwarf does not diminish generally proportionally with the height; at least such is the case when the dwarf is neither idiotic nor microcephalous. Thus we see that it is the lower limb which especially contributes to cause the tallness of giants and the smallness of dwarfs. The upper limb is susceptible of slightly less variations. The vertebral column and the skull are the least subject to vary with the height. It has been remarked that dwarfs are usually active, nervous, and at times choleric. A type, as regards this, was the famous Jeffrey Hudson, the favorite of Henrietta, Queen of England, and who had the honor of being painted by Van Dyck on the same canvas with his queen, and of being sung by the poet Davenant in his "Jeffriad," wherein is celebrated a victory obtained by the dwarf over a turkey-cock. Hudson was so small that he was served up at table in a pie, and he was so passionate that he once challenged to a duel a person named Crafs, who had made sport of him. Crafs came to the spot armed with a syringe only. The hero of the "Jeffriad," more and more furious, demanded a duel with pistols, in which he mortally wounded his adversary. He was then twenty-five years of age, and his height was only sixteen inches, although at the age of thirty he had grown somewhat and was three feet nine inches. Several other dwarfs, such as the Polish Borwilaski (three and a quarter feet), have shown themselves courageous and intelligent. On the contrary, we know that Bébé, the dwarf of King Stanislas Leczinski, was very stupid. It was never possible to teach him anything but to dance and beat time. His height at sixteen years of age was two and a half feet. His character, which, up to this time had been gay and frolicsome, then changed, and his height increased till it reached about three feet. He died at the age of twenty-two. He was engaged to a female dwarf, who, more fortunate than he, reached an advanced age. Unfortunately, the idea of measuring the limbs of these dwarfs never occurred to those who described them. Quetelet was the first to carefully measure the celebrated Tom Thumb—a dwarf whose reputation has not been forgotten, and who is only two and three-quarter feet in height. The few anthropometric measurements that have been made of dwarfs gives a greater value to Prof. Taruffi's Memoire. Unfortunately, his observations are comparatively few and relate to dwarfs whose stature was relatively large. His conclusions, then, cannot be regarded as absolutely definite.

WOMAN AS A SANITARY REFORMER.

AT the recent meeting of the Sanitary Institute, at Exeter, Eng., a lecture on this subject was delivered by Dr. B. W. Richardson, F.R.S.

After some introductory remarks, the lecturer said there was not any difficulty in the way of making woman the active domestic health reformer. The only thing which required to be considered was the method of bringing her universally into the work, and making the work a permanent custom or fashion, the neglect of which would be regarded as a moral defect. There was no nobler occupation than that which was applied under the head of domestic care and nourishment of health, and he would press the office of prevention of disease upon women, not simply because they could discharge its duties, not simply because it pertained to their special attributes, their watchfulness, and their love, but because it was an office which man could never perform, and because the whole work of pre-

vention waited and waited until woman took it up and made it her own. The man was abroad; disease threatened the home, and the woman was on the spot; the house was her citadel.

But by what process of training, it might be asked, could women so govern domestic life that diseases might be prevented wholesale? His reply was that the training required was simple; that every woman who willed to go through it might do so, and might become mistress by its means of the destinies of the world. A woman could master physiology so far as to understand the general construction of the human body. She could make herself acquainted with its nine great systems—the digestive, the circulating, the respiratory, the nervous, the sensory, the absorbent and glandular, the muscular, the osseous, and the membranous. She could be led to comprehend the leading facts bearing on the anatomy and function of those systems, to understand what part food played in the economy, the relationship which solid foods bore to liquid, and to learn what the particular foods were which were required for the young during the periods of active growth. If, possessing such knowledge, she would only utilize it, as she certainly would, we should, he would venture to say, have in this country hardly one deformed child at the end of one or two generations, and rickets, with all its attendant miseries of bowed legs, crooked spines, and bumped backs, would have passed away as if by the spell of an enchantress. After the understanding of the digestive system a woman should learn the principal facts relating to the circulation of the blood. She should know completely the mechanical construction of the heart, and how the heart was sympathetically moved in its action; for in the early days of childhood the whole after life might be shaped by the tone which was given to that organ. The complete structure of the breathing lungs should also be as plain before her as the outward forms of those things she knew best. Equally clear to her should be the leading facts bearing on that receptive system of the body into which the external universe transported itself.

How many young and middle-aged people, he would ask, were going about in spectacles, unable to see any object with the naked eye which was not uncomfortably near? How many of those also had their backs distorted, and whence arose that strange combination of deformity? The question was answered by Mr. Liebreich, who said: The greater part of it is induced while acquiring the art of writing. When the body is still being formed and is unconsolidated, the child is permitted to sit with the chest and back bent forward, and with the eyes close to the paper. Thus the natural refraction of the lenses of the eyeball is permanently perverted; the parallel rays of light are brought to a focus before they reach the retina, and there is produced the deformity of short sight, for the correction of which an artificial lens or glass is required. At the same time the back abnormally bent retains its abnormality, and short sight and curved spine go together, twin defects of one error which ignorance of the simplest principles permits the devoted and affectionate parent to overlook, as if it were a necessary and therefore irrepressible and irremediable evil.

Suppose the women of our country trained to the knowledge of the first and elementary truths about visual function, and guided by them, was it not all but certain that another deformity would in a generation become virtually a thing of the past? To the knowledge of nervous function it would be desirable to add a few facts respecting the great glandular system of the body, and the woman should, in the last place, study with special care that extended membranous expanse which was so sensitive to external influences of heat and cold, and in that way learn the value of keeping the functions of the skin in due cleanliness, so that the bath would come to be regarded by her not merely as a luxury, but as one of the necessities of daily life.

Having thus made herself acquainted with the living house, she would be tempted to inquire into the mysterious construction of that deadly-lively house which until lately the architect and builder had pitchforked into street and square, with a facile and contented wisdom of wigwam descent. She would endeavor to find out how she could most effectively and economically maintain in her house, in the varying seasons, an even and equable temperature. She would aim at discovering in what way she could keep the air of the house free from that most objectionable of mischief, dust. She would demand to have marked for her on a map or plan the precise position of every drain pipe in the establishment, and would insist with intelligent skill on having every drain kept as systematically clean as the china in the housemaid's cupboard. She would learn enough of the chemistry of water to enable her to determine, with as much facility as she could tell whether a looking-glass was clear enough to reflect back without fault the image of her face, whether the water was wholesome and drinkable, and she would possess a sufficient amount of skill to direct how an impure water might be purified and made safe for the purposes of all domestic requirements. She would see that sunlight found its way as freely as possible into every apartment, and that damp had no place in any one of her rooms. She would insist that where any living thing that ought not to be present in a house existed in it, that house was unclean. She would see to the biennial purification of her dwelling. She would make the very act of cleaning and cleansing clean, and the scullery, the landing, the bath room, the laundry, would be the cynosures of her household.

As to food, an intelligent study based on a knowledge of the natures and uses of foods, would enable her not merely to make the best selections and carry out the best modes of preparation now known, but would lead her to introduce new and improved methods of cooking. She would be able better than any one to put to the test of experience the question whether it was good or necessary to have recourse for human food at all to the living animal creation.

For his own part, it did not seem to him that man was constructed to be a carnivorous animal. It was by no means certain, seeing that the vegetable world was the original source of every particle of living food, that it was well to go for it to secondary sources of supply. But the point was one upon which he was in doubt. That doubt it was in the *rôle* of the educated woman to solve, and, however she might solve it, sure he was that, in watching carefully over food and feeding, she would quickly discover a world of facts that would be of unspeakable value. As to the art of the diagnosis of disease, he did not think the knowledge of it was necessary for women, except in a limited degree; but he would have them cultivate it to the extent of being able to tell the correct names and characters of the more common diseases, and of knowing by sight those which were contagious. To that knowledge they ought to add an acquaintance with the facts bearing upon the periods of incubation of those diseases, while all the best methods of preventing disease should be at their fingers' ends, and the rule of the sick room should be their constant care, for, as he had said many times, if, in the management and treatment of the acute and many of the chronic diseases, he could obtain in our climate absolute control of the fire and the windows of the sick room, he could determine the course of the illness.

Finally, a woman ought to have such a training as would enable her to resist with her full persuasive might that process which he had elsewhere called the intermarriage of disease, for she would know that diseased heredity united in marriage meant the continuance of that heredity, as sure as two and two made four.

A GREAT MEDICAL DISCOVERY.

By INVESTIGATUS DISCOVERANDUM, M.D., C—A. 10 A.C.

"Miserable de aquel, digo, que *tune* la honora espantadiza, i piensa que desde una legua se le *descubra* el *remedio* del zapato, el trasudor del sombrero, la hiloza del herreruelo, i la hambra de su estomago."—*Cervantes.*

IN this age of rapid progress, when one discovery succeeds another with the rapidity of thought, and the incandescent flashes of genius almost dazzle the eyes of applauding millions, it behooves original investigators to "hump" themselves in order to get their discoveries before the public, ere some one else is beforehand with them and carries off the laurel wreath. Many a proud reputation is blasted by being o'er long in the ripening, and ideas to make a lucky hit must strike square out from the shoulder without too much design or premeditation. If one would be a successful thinker he must think fast, for procrastination is as baleful to sensational celebrity as a corner grocery is to the benign influences of a Sunday-school.

Now, if there is anything for which we have talents it is for invention, and all the passion of our erudite nature is centered in original investigation; and on all the roll of honor there is nothing which tends to elevate us so much in our *own* estimation, as that which inevitably flows from the discovery of something new. Our genius has been patiently, diligently, and unceasingly taxed for lo! these many years to discover something that would incidentally benefit mankind at large, and directly benefit our "ainsel" in particular; something that would shed undying luster upon our name and at the same time fill our pockets. But, somehow, somebody has everlastingly been forestalling us. We might easily have invented the telephone if Edison would have minded his business and kept quiet awhile; or we could have developed a successful forty days' fast if Tanner had not pitched in; but there is so much competition in the field that it seems about as hard to get up a first-class medical or scientific sensation as it is to start a political campaign lie.

Some years ago we invested in a microscope, preparatory to going into the histological sensational discovery business, confidently believing that by carrying our researches into that teeming world beyond our ordinary vision's ken, we would find something, and we did. The first thing we found was that Lister had already set the world afire on the subject of bacteria; that he had taken possession, staked his claim, and fully occupied the whole domain of microscopic surgery.

But, nothing daunted, we turned our instrument toward medical topics, and as phthisis pulmonalis had hitherto baffled most pathologists, we thought it a fruitful field of research, and one in which we might find something. But before we could arrange our eye-pieces some infernal Dutchman bawled out "Yaw, mine Gott, I ish got him!" and sure enough he had a micrococcus all grooved, dove-tailed, and fitted into the pathology of consumption as nicely as you ever saw anything. But not in the least discouraged we raised our lens a little higher and prepared to pitch into laryngitis and diphtheria with a vim, but only to find that we were again too late, for that region was not only explored, but flooded with anti-bacterian solutions, and we had to beat a hasty though not ignominious retreat.

We next turned our attention to that pestiferous malaria so much talked about, determined to settle some old disputes by positive direct testimony from the unerring microscope, and we actually went to the swamp to investigate it, but before we could drive off the "skeeters" and commence operations, that yellow-faced Italian macaroni, Signior Strangdoodle Crudelli, or something of that sort, had done found them, gobbled them all up, and duly christened them after the forms and ceremonies of the Roman Catholic Church.

Such luck would have discouraged an ordinary genius and driven him from the field in despair, but we were not made of that "perishable stuff." When we buckled on our spurs, and dubbed ourself a knight of the lens, we inscribed on our shield that sage Latin motto "Nil Piserinctum," which being interpreted means "Don't give up the ship;" and in this instance we didn't. A mind fertile in expedients is a jewel to its possessor if to no one else, and we have a mind as elastic and grasping as the conscience of an ordinary Congressman, so we remembered a private, secluded disease; one supposed to arise out of our most intimate, social relations, and whose silence and privacy would be calm enough for an anchorite; one that when a person becomes the proprietor of it, he is not apt to blow much about his possession, and all the information he imparts concerning his condition is always in the strictest confidence. In this quiet domain we thought to direct our talents for observation, hoping, oh, so fondly! that we could, unmolested, unostentatiously and philosophically carry on our investigation, dig up our personal share of the much-coveted baccilla, photograph, and describe them, so that no one could be mistaken in their ear marks and lay a prior claim, and by so doing, enroll our name alongside of the immortal Lister. But, alas, for human expectations! before we could catch a case—No; before we could catch the—No, not that either; but before we could come up with an impecunious fellow-creature, with the aforesaid disease above mentioned, on whom we could experiment, behold! one Watson Cheyne, of King's College, has already discovered them in large numbers and recorded his name on the identical spot where ours ought to have been. Whether he is entitled to the credit of first turning his thoughts in this direction, or whether he just simply had the good luck to have a case on hand on which to experiment, and by this means outstripped American genius, will never be known until that day in which the sea shall give up its dead, and we will not pretend to contest the matter further, but allow him to fill his baccillated urethra with his antiseptic cocoa butter and repose on his laurels in peace.

But we think we've got them this time. It is a poor genius that never profits by experience, and as we've had the experience in abundance, we now propose to reap some of the profits. We intend to adopt the plan of a great many other progressives; advance the theory and then hunt up the facts to fit it at our leisure. We are not green enough after the experience we have waded through as an original investigator, to sit quietly down like Jenner, to years of patient toil, before we cry out Eureka; but we are going to cry Eureka first, and then hunt for it afterwards. We intend to be up to the requirements of the age, and announce an important etiological discovery, and then make the discovery when we feel like it. And inasmuch as the disease of which we have discovered the origin afflicts more people than yellow fever, cholera, and small-pox combined, we want it understood that we expect honor commensuate with the magnitude of the discovery. We intend to have a special congressional committee appointed to take it under consideration, and a special national board of health organized to take charge of it, with full powers to enforce quarantine in all infected localities, and fumigate, disinfect, and purify them, and armed and equipped to destroy the fell bacteria which cause so many aching hearts in this fair land, by the aid of science and the power of law.

The disease in which our investigations have led us, the pioneer as it were, to discover the much dreaded bacteria is CORNS; that is, we have not exactly found them yet, but inasmuch as they are found in all animal tissues alive, decaying, and dead, sound and unsound, we infer that they are also in *corns*; and being in *corns*, it is consonant to reason to believe that they are the *causa morbi*; for if they are not the cause of *corns*, what in thunder are they there for? It is the received orthodox doctrine of the present day, that where you find micrococci in diseased tissues, they are *sui generis* the cause of that particular disease, just the same as when you find a mud turtle in a puddle hole, that he is the cause of the puddle hole. These are fundamental principles of advanced pathology, which none may dare dispute. They are, as a distinguished advocate of the germ theory says, "accepted facts by the profession at large," and we have a perfect right to build our *corn* theory upon them, and no doubting Van Swiller shall dare to prevail against it. If the bacteria found in suppurating wounds are necessarily the cause of suppuration, and those observed in tubercle are the cause of consumption, and those found in the larynx the cause of diphtheria, and those found in swamps the cause of malaria, is it not reasonable to say that those which ought to be found in *corns* are the cause of *corns?* Then, such being the case, do we need anything else but a congressional enactment properly enforced to surround, isolate, and banish this terror of young and old from the land? And if Flint don't decide it to be a "self-limited disease," before Congress meets, we call upon all true lovers of sanitary science to aid us in procuring the necessary legislation upon the subject.

In consideration of the magnitude of this discovery, we hereby demand that our name be immediately enrolled on the highest pinnacle of fame; and that all the scientific societies of the world, including the lime-kiln club, take the necessary steps to confer an honorary fellowship upon us; that kingdoms, and principalities, and potentates present us with an annual pension, together with such other marks of merit as befits him whom the king delighteth to honor; and that towns, villages, and cities give us the full benefit of the free lunch system.—*Southern Practitioner.*

COPPER A PRESERVATIVE AGAINST CHOLERA AND TYPHOID FEVER.

AT the meeting of the Académie de Medecine de Paris, on March 30, M. Burq read an interesting paper on this subject. The paper gave the particulars and results of a number of observations and researches, which prove that workers in copper enjoy an almost complete immunity from cholera, and also to an almost similar extent from typhoid fever. It seems to be necessary for this immunity, however, that the copper powder with which the system is impregnated should possess a certain degree of purity, *ex. gr.*, not be attenuated too much by admixture with iron dust, and that the exposure of the copper dust should be constant. In view of these facts, the therapeutic value of the internal administration of copper in typhoid fever and cholera becomes a question of much interest.—*Jour. de Méd., etc., de Bruxelles.*

HEADACHE AS A SYMPTOM OF URÆMIA.

RECENT observations on the symptomatology of Bright's disease discloses the fact that severe pain located in the occiput may be regarded as one of the symptoms of the disease. Dr. E. C. Seguin has recently met with two cases (*Archives of Medicine*, August, 1880) in which occipital headache was so localized and persistent, as to give rise to a strong suspicion of organic disease of the cerebellum. In one case a positive conclusion was only reached by means of a post-mortem examination, which showed that the cerebellum and the other parts of the encephalic mass were normal, while both kidneys were extensively diseased. The left kidney was found completely diseased, granular and hard in places, its membranes peeling off with difficulty. It had a reddened, congested appearance, and showed evidences not only of a chronic trouble, but also of a more recent acute inflammatory action. The right kidney was found to be only partially affected—somewhat congested, and with the same type of lesion. These cases both now appear to have been examples of contracted kidneys and uræmia. Both patients were adults, had suffered from chronic headache, more or less of the migraine type; at a given period the headache became transformed into a localized occipital pain very different from the former attacks. The symptoms of renal disease were not marked; in one case there was no œdema, in the other a mere trace; neither patient had the dyspeptic symptoms or the frontal headache which often suggests renal disease, and neither patient had the "Brighty look" which is so well known. The occipital sensation in these cases was true pain, not the painful paræsthesiæ which are sometimes due to lithæmia and oxaluria, and sometimes to eye-strain, and which are erroneously (or rather insufficiently) designated as cerebral hyperæmia. In Case II. the pain extended down the cervical spine, and was so much aggravated by movement as to suggest a rigid state of the neck. In Case I. there was once stiffness of the neck in an attack. This peculiar headache was distinctly paroxysmal, but not at all periodical or influenced by any apparent outward circumstance. In both cases nausea accompanied the headaches, and in Case II. it is clearly stated that the nausea was secondary in point of time. Case I. was made relatively clearer by the previous history of convulsions and albumen in the urine.

Dr. Seguin is inclined to believe that the publication of these cases may serve to render more accurate the diagnosis of occipital headache, and to illustrate the utility of critically examining the urine in cases of any degree of obscurity, more especially as occipital headache is scarcely mentioned as a symptom of uræmia.

ON SOME POINTS IN THE MANAGEMENT OF ASTHENOPIC SYMPTOMS IN EMMETROPIC AND AMETROPIC EYES.*

By O. D. Pomeroy, M.D.

LECTURE I.

I will begin the lecture this evening by directing your attention first to the emmetropic eye. What are the conditions under which an emmetrope sees? You have already learned that an emmetropic eye sees distant objects perfectly at infinity, provided there is a relaxed state of accommodation; that is, with the ciliary muscle in a state of repose. You have also learned that the range of accommodation in the emmetropic eye varies according to the age. In a child ten years of age it will be about two and a half or three inches, it being represented by one divided by two and a half, or one divided by three inches. The range then gradually recedes until the person is a little over forty years of age, when it reaches eight inches, and then it goes out of the category of an emmetropic eye having a normal range. Then it is almost always the case that, if we would have perfect vision in the emmetropic eye, we must aid it by art. The internal recti muscles must have due strength as compared with the externi. The interni require to overcome a prism of 14° to 20°, with the base placed outward; the externi, being the weaker, will overcome a prism of from 4° to 8°, with the base placed inward, this ratio not being absolutely exact. Again, for purposes of near vision, it is usually stated that a person will work comfortably by using one half, or something less than half, of the maximum of accommodation; that is, the range of accommodation being one-sixth or one-seventh, the individual will read at thirteen or fourteen inches, which is about a proper distance. These general propositions being laid down as data from which future observations can be made, we are prepared to go on intelligibly in our study.

I will speak first of the means for relieving asthenopic symptoms *with* spectacles. You all understand what is meant by the term asthenopia. It is weak sight dependent upon insufficiency in the muscles which regulate the refraction of the eye; in other words, the muscle of accommodation and the interni. The patient may have normal range of accommodation—that is, it may be one-sixth—and yet the eye will be unable to read at thirteen or fourteen inches' distance for any length of time without fatigue or pain, for the reason that the muscle is not of normal vigor—it is unable to sustain the usual muscular tension for a reasonable length of time. That insufficiency of muscular power may arise from fatigue consequent upon overuse of the eyes. It may also come from insufficiency of muscular tone in the general system, all the muscles of the body being in a condition which does not allow them to bear excessive labor, the ciliary muscle and the interni being in the same condition as the muscles in general. I remember distinctly a lady whom I treated some time since, and I discharged her in as good condition as possible. Soon after, a friend asked after her welfare, and I said that her eyes were not strong, but that they were as good as any other part of her body.

Do not expect, by any means of culture or training, to make the eyes do proportionally more than other parts of the body which depend upon muscular contraction for the performance of their functions. If the ciliary muscle has insufficient power from fatigue or from general atony, we must help it by art, and we do that by adjusting a convex glass which takes the place, in part, of the accommodation which performs its function insufficiently. If this is the only defect, be careful to use very weak glasses. This proposition you may regard as a truism, namely, that the eye bears as much help as is needful, and any more than that is a hinderance rather than a help. It is difficult to explain this fact; but it is true that, if you put on too strong convex glasses—aid the ciliary muscle more than it really needs—pain, lachrymation, and general discomfort will be the consequence. So you are to guard against assisting this muscle too much. The convex glass may be very weak indeed, and yet be sufficient; generally from one-sixtieth to one-fortieth, will be borne. When we come to consider that $+\frac{1}{40}$ magnifies the type noticeable, it is easy to understand how very much assistance can be rendered by it, and in most cases it will be all that will be required to furnish the necessary aid to the ciliary muscle.

In this class of cases we will suppose that the interni are somewhat weakened in consequence of general muscular weakness, or from over fatigue; for, if the ciliary muscle is weakened, the interni are very liable to show some insufficiency. You will remember that the muscles—the ciliary and the interni—although their functions may be separated somewhat the one from the other, they usually work together.

Now we have adjusted a + 60, and the result is, in the first place, that type can be read at a greater distance because a larger visual angle is formed; and in the second place, the very fact of pushing the type or work away gives the interni less labor to perform, and, therefore, gives them rest.

By this weak convex glass we have treated insufficiency of the interni muscles, and insufficiency of the ciliary muscle as well, with a good degree of success.

DIRECTIONS FOR USING WEAK CONVEX GLASSES.

Ordinarily the patient will not need the spectacles in the early part of the day before any fatigue has come on; but in the after part of the day, when fatigue begins to overtake him, certainly in the evening, if gaslight is used, which is a defective means of illumination, glasses will be gratefully received. But if at any time the glasses give rise to pain at all, they should be abandoned. Remember that, if the patient needs no assistance, the glasses become quite intolerable.

TREATMENT OF ASTHENOPIC SYMPTOMS WITHOUT SPECTACLES.

If the patient is found to be fatigued by looking at an object at a given distance, the ciliary muscle may be relieved by pushing the object to a little greater distance. That is admissible only when the illumination is good and the type or object looked at is of sufficient size. This practice would not answer for reading very fine print or for sewing.

Again, if the interni are a little fatigued, you will often gain very much by using one eye at a time. This may be accomplished by using a patch over one eye, or using reversible spectacles, one eye of which has a bit of ground glass. The practice of shutting one eye is not successful. By these means the eyes may do a greater amount of work than otherwise.

The choice of illumination is a very important factor in the relief of asthenopic symptoms. The printed sheet should never be of a brilliant white color. I have noticed that *Scribner's Monthly* has extremely fine paper, but there is so much sizing in it that it has too bright a reflex. I was comparing the paper in that journal with the paper found in another, in which there was much less sizing, and the reflex was very slight. The paper which is to receive the printed impression should be of a dead white color, having no glistening reflex. A tinted paper, particularly that of a slightly yellowish tint, is very pleasant for the eyes. A blue paper would be pleasant enough, except that there is not quite sufficient contrast between the black letters and the color of the paper.

If artificial light is used, it must not be too bright. The lamp chimney may have a light tint of blue, causing the illumination to resemble daylight. The printed page should be well illuminated, but not excessively.

Another good rule for relieving asthenopic symptoms is to be careful and not use the eyes too long at any one time. A rest of two or three minutes is often very grateful indeed to the eyes. It is quite a safe rule to stop using the eyes every twenty or thirty minutes. In a long sitting it will be found that more work can be got out of the eyes comfortably by frequent rests than by continuing the labor until the eyes become considerably fatigued. This is also a good rule to be observed with reference to all kinds of work. The use of prisms, when the interni are somewhat insufficient, is often indicated. For myself, I have not had so happy an experience with prisms as I could have wished. You can state in general terms that if there is considerable insufficiency at the *far* point, prisms will be borne. For instance, if the insufficiency at the far point should be 10° or a little more, the patient will be benefited by the use of prisms in reading; and I should suggest a prismatic power a little less than one-half the insufficiency at the far point, divided equally between the two eyes, the bases of the prisms being placed inward, as about the proper proportion. Suppose, for example, the insufficiency is 12° at the *far* point, I should say place one prism of about 2½° over each eye.

The lenses may be so constructed as to have the thicker portion placed inward, thus acting as a prism.

Another thing which may be done in insufficiency of the interni is tenotomy of the tendons of one or both of the externi. A few years since this operation was extremely popular. The change in the position of the eyeball produced by division of the external rectus muscle is very slight indeed, and frequently there is no change at all. The proper method of performing the operation, if it is done, is to lift the conjunctiva from over the muscle, and, making the smallest possible incision in it, pass in the hook, catch the tendon, and divide it exactly at the point of insertion without dissecting the conjunctiva from the tendon more than the smallest amount. The objection to this operation is that it frequently produces diplopia when the patient is looking far toward the divided muscle, and for that reason principally it has been discarded. When I come to speak of myopia I will develop that point somewhat more thoroughly than at present.

THE USE OF ATROPINE IN THE TREATMENT OF ASTHENOPIC SYMPTOMS.

Whenever I meet with a patient who has evidently fatigued his eyes by overwork, my first thought is with reference to the use of atropine. A solution of four grains to the ounce, and a few drops instilled into the eyes three times a day for two or three weeks, rests the eyes much more rapidly than any measure which I have employed, and besides, it relieves whatever ciliary neuralgia may be present. While the atropine is being used, smoked glasses should be worn to prevent the entrance of the flood of light which would otherwise pass through the dilated pupils.

THE GENERAL HYGIENIC MANAGEMENT OF ASTHENOPIA IN THE EMMETROPIC EYE.

Inasmuch as the asthenopic symptoms in the emmetropic eye depend largely upon insufficiency of muscular power, all our treatment should be directed toward the improvement of the general condition of the patient. I have often observed that asthenopic patients, after a full meal, possibly with wine, could use their eyes very comfortably for a short time, in consequence of the temporarily improved hygienic condition. Certainly, the habits of life in all these patients should be studied in the most careful manner. If they are leading a sedentary life and are confined largely indoors, reverse the order if possible, and send them into the open air. Cause them to obtain proper exercise, as much as they can comfortably bear, and do all that can possibly be done to improve their physical condition. Feed them with the most nourishing food, keep the skin and the bowels in good condition; in short, do all that is necessary to bring them to the top of their condition.

DYER'S PLAN.

There is another element in these cases. The patient often loses confidence in his eyes: that is, he can use his eyes better than he thinks. Having fatigued them a number of times, he becomes discouraged, and concludes that he cannot use his eyes at all. For these patients, what is called Dyer's plan—giving carefully regulated gymnastic exercise to the muscles of the eyes—is extremely valuable. So far as this part of our subject is concerned, it is based upon a very simple proposition, namely, change of the relative accommodation; that is, the innervation of the ciliary muscle and the interni are not equal, the interni being contracted more strongly than the ciliary muscle by the use of the convex glasses adopted in this method.

A convex glass before the eyes in reading will help the ciliary muscle, but afford no assistance to the interni; so the relation is changed; the relative accommodation is not the same as it was before the glass was adjusted. This is the first phase of the question, and the second is a systematic and careful exercise of the ciliary muscle. Some patients are so asthenopic as not to be able to use their eyes more than two or five minutes at a time without excessive fatigue or pain. These patients are found in the higher rather than in the lower walks of society, and they are extremely annoying to deal with. There is one element in this method which can be used to assist in controlling these rather unmanageable patients, and that is, almost anything which occupies their attention under the pretense that they are to do exactly as they are told has a good effect upon their morale. Dyer's plan calls for the use of weak convex glasses in this class of cases, and the patient is to use the eyes a certain length of time three or four times a day. Begin to day, for example, with two minutes; to-morrow the time can be extended to three or four minutes, and so gradually increase the length of time until a respectable amount of reading can be done. Some have said, compel the patient to use the eyes whether they become painful or not. I am disinclined to follow that practice, but prefer to adopt the method which is best expressed by a sort of Hibernianism, let them stop and rest their eyes before they are fatigued; in other words, avoid any approach to excessive or noticeable fatigue. The moment that the patient finds reading is done uncomfortably, he should stop and rest the eyes a few minutes.

Guided by this maxim, you go on, allowing your patient to use the eyes so many minutes the first, and then adding a few each succeeding day; but if at any time the amount of time added gives any special discomfort, go back at once to the point at which the exercise can be continued with ease. Beware of pushing this gymnastic exercise *too far*. Some men admit of almost any amount of muscle training, but others have a very finite point beyond which they cannot be carried with safety. I have now in mind a patient who received the advice of some half dozen of the best ophthalmic surgeons in New York and Brooklyn, and was finally under the care of one gentleman who had special skill in the use of the Dyer plan of gymnastics for the eyes. She was a sensitive, weakly girl. That gentleman brought her from being able to read only a few minutes three times a day to ability to read one hour and a half three times a day, when suddenly she broke down and went back to the beginning, and she has as yet scarcely recovered from the effects of the overstraining of her eyes. To digress a little, I remember a lady who could sing extremely high notes, and her music teacher, taking pride in exhibiting her powers, practiced her high notes excessively for two or three days, when suddenly her voice broke down, and she did not recover for the next twelve months. So you have to be extremely careful, and study the cases in all their details, and not make the mistake of overdoing the gymnastic exercise.

INDICATIONS FOR THE USE OF GLASSES IN PRESBYOPIA.

Presbyopia naturally follows the subject we have just been studying. By presbyopia, as you all have learned, we mean the limitation of the range of accommodation, which is expressed by any fraction greater than one-eighth; that is, if the range of accommodation is less than one-eighth, we call the patient presbyopic. The person still has an emmetropic or normal eye. The adjusting power, however, gradually growing less and less from ten years old upward, has finally extended the near point of distinct vision beyond eight inches. The near point having passed beyond this distance, why should that produce trouble in reading? The answer is as follows: we take less than one-half of the whole range of accommodation and give that as the point at which the patient will read comfortably.

We will say that the patient has presbyopia one-ninth; the reading distance, therefore, will be something like twenty inches, which will cause ordinary type to subtend an insufficient visual angle, and make it impossible to read with comfort at that distance. Even if we could, it would be found to be inconvenient to hold a book so far off. Fine print must be held within ten to fourteen inches to be seen comfortably.

You will remember, when I spoke of tests for vision, that I said they were not absolutely exact. We learned that twenty-twentieths was normal vision; but if you illuminated the type with sufficient care, smaller type might be read. The presbyopic patient will read fine type, if sufficiently well illuminated, at a greater distance than its number would indicate, namely: No. 1 may be read at sixteen or eighteen inches instead of twelve; from these considerations you can say that the presbyopic patient needs help, and that must come from convex glasses.

It is foreign to our purpose to speak here of the physiology of presbyopia, and we will pass to the simple rule for finding a presbyopic glass, and that is, to bring the near point back to eight inches. How shall that be done? In the simplest possible manner. Suppose that the patient has presbyopia one-twelfth; that would be represented by a twelve-inch *plus* glass, and you wish to bring the near point back to eight inches. A *plus* eight-inch lens will bring it back to eight inches without the aid of the adjusting apparatus of the eye, when, we have just so much too much power, as is represented by his accommodation,—and the equation will read one-eighth minus one-twelfth equals the lens sought, with which he will read comfortably.

Again I have told you that, in order to select properly the glass by this method, you must obtain the near point of vision with great exactness. You will remember that a few evenings since it was shown how difficult it was, sometimes, to get the exact near point. In order to test for the near point you must have just as fine type as the patient can read at a given distance. If he is presbyopic one-twelfth, and his vision is twenty-twentieths, you must take No. 1 of Snellen. Why? Because, if you take 3 or 4 or 5, he will read it nearer than twelve inches; but the object is out of focus, he sees it through circles of dispersion. The fine print cannot be seen through circles of dispersion, and therefore the exact position of his near point can be estimated. There is considerable difficulty in getting hospital patients to read as near as they possibly can. They are people who are not under much discipline even at their very best, and that fact will be a source of great annoyance to you. If you wish to avoid the difficulty incident to this plan I will give you a simpler method, and that is to take the weakest glass with which the patient can read *comfortably* and for some time at thirteen or fourteen inches. If the patient is just beginning to wear glasses, I recommend him to use one not stronger than one-fiftieth or one-sixtieth. It is to the patient's advantage to retain his accommodation as long as possible; and it will astonish you to see how much help $+\frac{1}{40}$ will give him. I have given glasses of $+\frac{1}{40}$ to old gentlemen of sixty years of age, and they have worn them with great comfort for a considerable time.

If the glass selected by the above rules gives no unpleasant sensation of straining the eyes, no lachrymation, no unpleasant feeling in the epigastrium, after reading for ten to twenty minutes, you may be quite sure you have a properly selected lens. This glass should be changed once in one or two years, gradually making it a little stronger, but encouraging the patient to use the accommodation as much as he comfortably can.

There is nothing more annoying to a patient than to have lost the adjusting power of the eye. You may remove a cataract from a patient's eye and get vision twenty-twentieths as the result, and yet he will not be particularly thankful, for he has an eye without adjusting power, and in order to read he must hold the paper at exactly a given distance, otherwise it is out of focus. At a distance he will see well with the glasses that neutralize his hypermetropia, but any object between the far and the near point will be out of focus, which of course is very annoying. If there is amblyopia in conjunction with presbyopia, you may use glasses of a greater strength than indicated by the rule laid down, for you thus increase the size of retinal images, and in that manner diminish the amblyopic symptoms.

* Lectures delivered at the Manhattan Eye and Ear Hospital.

The directions to be given when the patient begins to wear presbyopic glasses should be nearly in accord with the rules laid down in the early part of this discourse, namely, encouraging him to go without glasses in the early part of the day while the adjusting muscles are strong and willing to work, and resorting to the spectacles in the afternoon and evening when he will the better appreciate their assistance.

THE USE OF GLASSES IN AN APHAKIAL EYE.

In an aphakial eye, an eye which has lost its lens, either by extraction or otherwise, if emmetropic, or normal, there is a hypermetropia of about one-fourth. But you do not know in a given case whether or not the eye was previously emmetropic; so you are obliged to determine, either by the ophthalmoscope or experimental tests, what the exact number is which should be worn. As a rule, + ¼ will give the best vision; but always try a cylindrical lens, or even some other power of spherical lens, unless vision comes up to twenty-twentieths. If vision by the use of + ¼ is twenty-thirtieths, try a cylindrical lens, because occasionally vision after extraction may be brought up to twenty-twentieths. As we are all anxious to get the best possible results after cataract extraction, I have in a number of instances had the pleasure of illustrating to private pupils the great improvement to vision given by cylindrical lenses in extraction cases where a spherical lens had previously been used with inadequate results. It has seemed to me that a cylindrical lens was more likely to be accepted after extraction than after solution of cataract. What glasses shall we give the patient to *read* with? If vision is twenty-twentieths or twenty-thirtieths, we may content ourselves by adding to the previously correcting lens a + $\frac{1}{12}$, which will enable the patient to read at twelve inches. It is frequently the case, however, that there is a good deal of amblyopia, or bad sight, in consequence of imperfect results, and then we gain by giving a glass too strong, so to speak. You may bring the near point up to five or six inches, because here is one eye only to deal with, and there is likely to be very little contraction of the internal recti muscles to annoy the patient.

Watchmakers wear a two-inch lens over one eye for twenty or thirty years, and work with it a large part of the time, without much fatigue to the eye. At first it is usually tedious to bear the tension of the accommodation; but after awhile they manage, by a species of unconscious experimentation, to get the exact adjustment, and work without trouble, the interni participating very little, if any, in the visual act.

One objection to using a glass which places the near point at three or four inches would be the unpleasant approximation of the object; but in any given case a glass which will enable the patient to read the usual coarse print of the family Bible will fill him with delight. You will often hear it said, after cataract extraction, that the patient read No. 1 of Snellen's or Jaeger's test-types, and, at first glance, that seems like an excellent result. But do not be misled by a statement of that kind; for nothing but vision obtained at the far point is altogether satisfactory evidence of the state of vision.

Of course, vision would be twenty-twentieths if the patient read No. 1 of Snellen *at* twelve inches; but the fallacy comes in here—a lens is used that brings the near point to five or six inches, and reading No. 1 at that distance does not indicate perfect vision.

LECTURE II.

The first topic this evening is hypermetropia. This is a condition of the eye which arises, probably, from arrest of development of the eyeball in which the antero-posterior diameter is too short. The lens and the cornea represent about the same refraction as that of the emmetropic eye. The eyeball being too short, it necessarily has insufficient refractive power. We have already learned that the emmetropic eye is in a state of absolute repose at the far point; that is, objects seen at a distance are accurately focused upon the fovea centralis without the aid of muscular contraction. Light falling upon the emmetropic eye of a dead man, according to this theory, would reach an exact focus upon the fovea. That statement requires some modification. In a large majority of children, the eye, under atropine, will be found to be hypermetropic unless it is myopic. This is much more often the case than with adults. I have examined the eyes in quite a large number of adults under atropine, and have found that not more than five per cent. emerge from its influence without having been found to be hypermetropic or myopic. For producing this effect you may use a four grain solution, and instill a few drops into the eye three times a day, for from one to three weeks, and thus put the muscle of accommodation into a state of absolute repose. In explanation of this fact of generally finding a lower refraction after atropia, I am inclined to offer the theory advanced by Donders, namely, that a certain allowance must be made for a species of normal tonicity of the ciliary muscle. He says from $\frac{1}{60}$ to $\frac{1}{40}$; that is, if the ciliary muscle is in a state of absolute repose, the eye would require a convex lens of from $\frac{1}{60}$ to $\frac{1}{40}$ to bring the rays of light to a focus upon the fovea.

I would define hypermetropia, practically speaking, to be a condition of the eye in which refraction is lowered more than from $\frac{1}{60}$ to $\frac{1}{40}$ with the ciliary muscle in repose, by atropine or otherwise. The range of accommodation in the hypermetropic eye is frequently more than in the emmetropic eye, which will be an important element in our studies relating to the action of lenses in aiding vision in this class of cases. The hypermetropic patient has been so necessitated to intensify the action of the ciliary muscle to overcome the hypermetropia that he has gymnastically increased the power of the muscle. Likewise the power of the interni has been increased in a similar manner, which will account for the existence of convergent squint in some hypermetropic eyes; that is, the interni, by constant effort to equal the innervation of the ciliary muscle, become hypertrophied to such a degree that their opponents, the externi, are incapable of maintaining the eyeball in the proper position for binocular single vision, and the consequence is convergent strabismus in one or both eyes.

As to the use of glasses in hypermetropia. We started with the proposition, in speaking of emmetropia, that to read comfortably for any given length of time, at the usual distance, the patient would be required to call forth a little less than one-half the range of accommodation. The hypermetropic eye frequently having a greater than normal range of accommodation, can, on account of that, often work without glasses with perfect comfort. For instance, the range of accommodation may be ½; if we divide that by two, we have ¼, which is more than needed. Then if he has a hypermetropia of $\frac{1}{12}$ to $\frac{1}{8}$, the reading distance will be removed to the proper point—namely—thirteen or fourteen inches. Moreover, in the management of hypermetropia we meet with precisely the same question that confronted us when studying the management of emmetropia—namely—ciliary muscles differing greatly in contractile power. By the rule already laid down, to use one-half of the range of accommodation, you can see that some cases would require glasses and others would not.

The management of manifest hypermetropia in very young subjects. I will speak of this separately. A very large proportion of young people have, as we previously stated, a certain amount of hypermetropia. Frequently it is facultative; that is, they will see just as well without convex glasses as with. It comes to be a question whether you will correct their ametropia or not. If there are no asthenopic symptoms, do not use glasses; if there are, use them. But you will frequently find, after the ciliary muscle becomes rested on account of the use of the spectacles, that the glasses will be thrown off as something not to be longer tolerated. I have in mind a case: a young man, sixteen years old, had manifest hypermetropia of $\frac{1}{12}$ and asthenopic symptoms. I prescribed $\frac{1}{12}$, and he wore the glasses a year with comfort; they began then to worry the eyes and he found that he worked better without than with them, and I therefore told him to discard them. He did so, and ever since has worked comfortably without the aid of glasses.

In a patient of middle age, I should, as a rule, neutralize all the manifest hypermetropia, and let him wear glasses for distance, unless he found, after awhile, that he was just as comfortable without glasses as with them. But if he previously had asthenopic symptoms, he probably would bear to use the glasses constantly.

At the near point he may use glasses which nearly equal or even exceed the total hypermetropia, and the glasses can be determined by the rules which we adopted in fitting glasses for presbyopia—namely, take the lens which corrects the manifest hypermetropia, and see what the range of accommodation is; if it be less than ⅛, find by the plan previously stated what glass will bring the near point up to eight inches; this, added to his hypermetropic correction, will give the proper reading glasses.

CONVERGENT SQUINT AND HYPERMETROPIA.

I will say a few words regarding the management of convergent squint in hypermetropia. A good deal has been attempted in relieving convergent squint without tenotomy, especially if it is what is called periodic squint, the earlier manifestation of strabismus. It is a fact that many young patients who occasionally squint may have convex glasses adjusted to their eyes, which will relieve the tension of the interni so completely as to cause them to use their muscles so moderately as not to give rise to a squint at all. But that plan has not succeeded as well as was anticipated. I have coming to the clinic a patient in whom I had corrected the convergent squint by a tenotomy. Afterward the squint returned. The eyes now are perfectly straight while he wears glasses, but if he leaves them off even for a few minutes the squint returns.

GLASSES AFTER TENOTOMY FOR CONVERGENT SQUINT.

As to the strength of glasses to be used after tenotomy, I do not always use correcting lenses after tenotomy for convergent squint, even in hypermetropia. If there is a considerable degree of hypermetropia I always do. In young children, who are very prone to relapses after tenotomy, I always use a correcting lens, *provided* I find a considerable degree of hypermetropia. That is usually satisfactorily found by the ophthalmoscope only. I am in the habit of making a diagnosis of all the hypermetropia which may be developed by the ophthalmoscopic examination, and fitting the patient with glasses thus found. I direct them to be worn for a longer or shorter period of time. A case will illustrate this point. A child four years of age was operated upon by me for convergent squint. The eyes became straight, but relapses occurred several times. I caused her to wear glasses which neutralized all the hypermetropia diagnosticable by the ophthalmoscope. As long as she wore the glasses her eyes were straight; but leaving them off for a few hours only, the squint would return. I directed that glasses be worn constantly, but to leave them off when it could be done without causing a return of the squint. After three or four months the parents came with the joyful intelligence that the child was able to discard the glasses without provoking a return of the squint. Up to the present time the eyes remain straight. Even if you overcorrect the hypermetropia in little children, I do not know as it does any special harm. I do not now recall a case in which pain, lachrymation, or appreciable discomfort has resulted from wearing glasses which were too strong to correct the hypermetropia. The worst they can do is to induce an artificial myopia.

ATROPINE IN CONVERGENT SQUINT IN THE HYPERMETROPIC EYE.

Atropine has been used to correct the convergent squint of hypermetropia. I think Dr. John Green, of St. Louis, kept the eyes of a patient under the influence of atropine for from one to two years, with the view of curing the squint. So long as he used the atropine the squint was relieved. In some cases, however, this good result was not obtained. After the patients recovered from the atropine the squint commonly returned; so I believe he has abandoned the device of curing the strabismus in this manner. I do not by any means find that atropine will prevent even periodic squint, except very infrequently. Theoretically it may do so, because it relieves the interni from the extra tension which develops the squint.

THE VISION OF HYPERMETROPES

If the patient has a high degree of hypermetropia, you must not expect to bring vision entirely up to the normal $\frac{20}{20}$ +. I have previously hinted at the fact that the hypermetropic eye exhibits signs of arrest of development, and functionally it will often be found faulty. I think these persons have a smaller optic nerve and a less development of the retina than exists in the normal eye. I have often fancied that the visual field was a little limited in high degrees of hypermetropia.

ASTIGMATISM IN HYPERMETROPIA.

In managing the astigmatic symptoms of hypermetropia, a little skill is required. I think I generally find the astigmatism about the same before the use of atropia as after. Sometimes it may be somewhat increased, but the amount of astigmatism, certainly in adults, which is revealed by trial glasses, before atropia, is a fair guide to go by. You have frequently heard it said that such a patient has too small an amount of astigmatism to be worthy of correction. This is frequently the case in hypermetropes, but not often in myopes. Here we follow the law already stated, namely, if we have a vigorous ciliary muscle it may overcome slight degrees of astigmatism without trouble. I will state a case. A gentleman, 46 or 47 years of age, had a small amount of astigmatism (+ $\frac{1}{20}$), which was diagnosticated at that time. He asked for glasses on account of moderate presbyopic symptoms. I told him that his right eye was slightly astigmatic, but that I thought it would not give him any trouble, and advised him not to go to the extra expense of a cylindrical glass. He went away, used the glasses prescribed for about a year, and then returned, saying that his right eye had pained him somewhat, and that it watered. In other words, it began to show asthenopic symptoms. I then saw that it was necessary to correct the hypermetropic astigmatism, and he has had no asthenopic symptoms since. You will conclude by this that at the beginning it may be a kind of experiment as to whether or not you will give the patient a glass that will correct the hypermetropia. Of course, with only a moderate degree of hypermetropia and a strong ciliary muscle, he would prefer to avoid glasses.

Some years ago, by the advice of a distinguished gentleman in Berlin, I purchased a set of cylindrical lenses ranging as high as $\frac{1}{10}$. But since that time it has been found that this number is much too strong for some cases, especially for myopes; and even in hypermetropia we find occasion to use a cylindrical lens as weak as $\frac{1}{40}$. Some go much finer than that, but I can hardly see any proper indication for so doing. Insufficiency of the interni in hypermetropia may be managed precisely as in emmetropia.

MYOPIA.

In myopia there exists a condition exactly the opposite to hypermetropia; that is, the eyeball is too long instead of too short. It is more than that. It is frequently, indeed almost always, a more or less diseased eye. The length of the eyeball is due to an ectasia or bulging of its posterior portion. This may be a thimble-shaped projection located in the region of the fovea; it may reach the border of the disk, or any other portion of it, or the whole may be included. It may extend even to the equator of the eyeball. You will perceive by this why we are so uncertain in our diagnosis of the refraction of a myopic eye by the ophthalmoscope. It is extremely difficult, if not impossible, to diagnosticate exactly the refraction of the fovea centralis without the aid of blood vessels, which are not found in this region, and the best I can suggest is to observe the refraction as near the macula as vessels are found. This refraction may be a little more, perhaps a little less than that determined by the trial glasses.

The cause of the bulging of the eye in myopia is a disease which Graefe called sclerotico-choroiditis posterior, and is almost always accompanied by posterior staphyloma. It produces changes in the choroid resulting in atropic patches here and there, stretches the retinal tissue, sometimes causing detachment, and induces quite a variety of retinal disturbances. So in a large number of cases of high degrees of myopia you will find that amblyopia enters largely into the problem of the selection of glasses. In consequence of this bulging of the eyeball, it presses rather heavily upon the fatty connective tissue cushion at the posterior part of the orbit, and hinders mobility of the eyeball in a purely mechanical manner. In consequence of this the ocular muscles, notably the interni, will be found quite insufficient to proper mobility of the eye.

Insufficiency of the interni is quite characteristic of myopic eyes, and it sometimes exists to the extent of causing divergent squint. In hypermetropia, you remember, we occasionally have convergent squint. This is an element which requires careful consideration when glasses are adjusted.

WHAT GLASSES SHOULD BE GIVEN TO A MYOPE?

It has been laid down as a rule in many of the books, including Donder's, that if the range of accommodation in the myopic eye is normal, you can give the patient glasses for distance that neutralize the myopia, and which may be worn for constant use. This rule, very frequently, is not to be relied on. I can explain the fact only by referring to two theories.

The ciliary muscle in myopia is frequently quite weak. In general terms you will find that a myopic eye works much more comfortably with the accommodation considerably relaxed.

Again, in myopia, we have to deal with what is extremely troublesome; that is, any disturbance of the relative accommodation. Take, for instance, a myopia of one-sixth; the patient will read with the far point at about six inches; his accommodation will be almost completely relaxed, but the interni represent a convergence of six inches. He may have done this so long that he will do it with comparative comfort. You can readily see that this is an artificial condition, due simply to a long continued habit, and it is extremely difficult to cause the patient to use his eyes under different conditions. Now correct the myopia and then notice the change. At the *far* point he will see objects with relaxed accommodation, and instead of the interni converging at a point six inches distant, the parallelism of the eyes must be retained, which necessitates a prodigious tension of the externi, and thus gives very great discomfort. To avoid this complication of changed relative accommodation, we select glasses for distance which do not wholly neutralize the myopia. I have already stated that in myopia you must attend to the condition of amblyopia.

Do not forget for a moment that the myopic eye is often better able to read fine print for a longer time than even the emmetropic eye, because it has, from the mere fact of its myopia, a *magnifier* before its eye, and the interni are so well accustomed to this condition that they give little or no trouble, even in excessive convergence.

When I tell you to allow the patient to have a glass that neutralizes the myopia, to wear constantly for all kinds of work, he should find it comfortable; if not he must lay it aside. In any event you may neutralize all the myopia with a glass which is occasionally used for distant objects only. Now, for glasses which he can wear constantly with some comfort, I should say select those which will cover points from six to ten feet distance. They will enable distant objects to come out to a reasonable degree of clearness, and will not strain the muscle of accommodation unduly in looking for a few moments at near objects. What shall we do for reading glasses? If the myopia is from one-eighth upward I should not give reading glasses at all. *Some* patients with myopia one-sixth read better without than with glasses. But if you have concluded to give glasses for reading it will be for the higher grades of myopia; give those which only remove the myopic far point a little distance away. A high degree of myopia should not have the reading distance pushed beyond from seven to ten inches. But the element of empiricism comes in here very strongly.

On the subject of high degrees of myopia and ability to do good work without glasses, I would cite a case of this kind. In myopia, vision in one eye is sometimes very poor, or one eye may be much more myopic than the other. The myope

will by preference, then, use the best eye. While riding in a street car some time since, with a professional gentleman and his wife, we noticed a man opposite us who was reading a newspaper held not more than two or three inches from the eyes. I remarked that he was reading with only one eye, and the doctor's wife being rather incredulous upon that point, took the pains to make the necessary observation, when she found, sure enough, that the man had one eye widely deviating from the object, while the other was fixed upon it. These patients will frequently do that, especially if they have a high degree of amblyopia. You will remember that I told you watchmakers could work with a single two-inch lens without fatigue for many years; the interni, of course, not being engaged, the proper amount of accommodation is readily adjusted.

In myopia or hypermetropia, if the eyes have different degrees of refraction, I would follow this rule: if the difference between the two eyes is more than $\frac{1}{20}$, I would fit the best eye; that is, the eye which has the least myopia or hypermetropia, and the best vision, giving the same glass for the other eye. If the difference is less than $\frac{1}{20}$, I should fit each eye separately. Considerable trouble will be required on the part of the patient to adjust for comfortable vision even here. You have two eyes requiring quite dissimilar glasses; you have two retinal images differing from each other in size, and these have to be fused into one image by a mental process. In myopia, select the weakest glass that will correct properly, otherwise the accommodation becomes unduly intensified.

Several years since I fitted a patient with glasses for myopia and astigmatism. Having no minus glasses weaker than $\frac{1}{3}$ at that time, I used that, and it seemed to correct the error well enough. He used the glass something like a year, and then came back, saying that his eye began to pain him. Since the first fitting of the glasses, I had had made for stereopticon purposes a set of cylindrical lenses running up to $\frac{1}{12}$. Looking his case over carefully, I found that $\frac{1}{12}$ cylindrical corrected his myopic astigmatism perfectly, and all the asthenopic symptoms promptly disappeared.

Insufficiency of the interni in myopia is extremely important, because it frequently develops into divergent squint, as well as produces asthenopic symptoms. If a squint is present, you may operate, and usually in divergent squint the interni must be advanced either one or both. But if the insufficiency is moderate, say 10° to 16°, you may correct that by prisms with the bases placed inward. In selecting the prism you will be guided by the rule already laid down, and that is, use about one-half the prismatic power which represents the insufficiency at the far point and distributed equally between each eye.

Some ten years ago, as near as I can recollect, Pagenstecher, of Wiesbaden, and others, practiced division of the external rectus muscle to relieve the asthenopic symptoms resulting from insufficiency of the interni. I have done the operation in only two cases, both moderate degrees of myopia and noticeable insufficiency of the interni, not sufficient, however, to spoil binocular single vision, and in each case I relieved the asthenopic symptoms, but I had the same experience many others have had—namely—whenever the patients looked far in the direction of the divided muscle, they had a certain amount of diplopia. In my cases this did not produce serious discomfort, but with this possibility in view, and on account of the large experience of others, which condemns the operation, I have abandoned it.

Another means of relieving the fatigue and ciliary neuralgia of myopic eyes is atropine. For this purpose a four-grain solution may be used three times a day, or sufficient to put the ciliary muscle completely at rest. Of course smoke or blue glasses may be used while this is being done.

A myopic patient should not bend over his work. He should do nothing to cause blood to go in abnormal quantities to the region of the eye. Again it may be used as an argument in favor of the use of glasses, that the patient can then hold his head erect and thus prevent the congestion of the eyeball that is likely to increase the previously existing disease, consequent on bending over his work. Dyer's plan is applicable here as in hypermetropia.

In myopia you may use a very weak concave glass to slightly change the relative accommodation.

Sometimes you will be extremely annoyed to find that the myopic eye refuses every form of spectacles. I would explain that fact upon the theory that the patient, for some reason not understood, cannot bear to have his relative accommodation changed; not even by the use of prisms which would retain, in a measure, the same condition of relative accommodation that previously existed.

From what has been said you will conclude that the matter which we have been studying is not one of exact science; that is, we are obliged, as yet, to partially recognize the empirical element. That glass which is worn comfortably by the patient, and relieves his asthenopic symptoms, is, evidently, the proper glass for him to wear.

ANTHRAX.

AN important communication was made to a recent meeting of the Académie de Médecine by M. Bouley. M. Toussaint lately announced the discovery of a method of preventing anthrax in sheep. It was proposed to inoculate them with the blood of an animal suffering from the same affection, defibrinated and freed from bacteria by filtration In order to test the correctness of the statements of the practicability of this method, M. Bouley obtained from the Minister of Agriculture twenty sheep, of which sixteen have been inoculated with the defibrinated and purified blood from a case of anthrax. Four of these animals immediately died with grave symptoms of anthrax, and the twelve others presented symptoms of illness so severe that it was thought at one time all would die. These results indicate no immunity from the effects of inoculation, but rather an innocuousness of the liquid employed. Successive and minute filtration, heating to 50° C., or the addition of a small quantity of carbolic acid, do not remove all the bacteridia from the blood. They simply lessen their number to a very minute proportion, and if animals resist inoculation with blood so treated, it is because the germs of the disease are given in too small a quantity to cause fatal accidents.

The varying resistance of sheep of different races appears to be rather a question of susceptibility to dose than of absolute indifference. Some time ago M. Chauveau found that in inoculating with infected blood a series of sheep, there were always some which resisted, while others succumbed. He soon found that the refractory animals were always foreign—from Barbary. He found, however, that an inoculation of blood which would kill one of the indigenous sheep did not leave the foreign sheep unaffected. They presented mild symptoms, such as slight fever, swelling of the lymphatic glands, etc. If the dose of poison was increased these animals also perished. If, however, one of these Barbary sheep was repeatedly inoculated at intervals, the effects became slighter and slighter after each inoculation, and the animal ultimately became indifferent to the poison. Moreover, lambs born of ewes which were inoculated in this manner during the latter period of gestation seem to have acquired a greater immunity than that possessed by the ancestor. It is suggested that Barbary sheep, thus rendered secure, should alone be pastured on land in which the germs of the disease abound.

It is important, however, to remember that facts lately ascertained by Dr. Greenfield seem to show that animals very susceptible to the poison may have their susceptibility greatly lessened by inoculation with poison which has been rendered feeble by passage through the system of a rodent. The facts discovered at the Brown Institute, that the virulence of the poison can be thus lessened, and that it can thus be employed for successful inoculation, is one of the highest importance.

The disease is attributed popularly to effluvia from the land on which the disease occurs, but its origin seems to have been satisfactorily ascertained by M. Pasteur. He has proved that the germs of the disease—that is, the bacteria—are transported to the surface of the soil by earth worms. Having collected the excremental dirt thrown out by earth worms on the surface of the soil in a locality where a cow dead of anthrax had previously been buried six feet deep, he obtained by cultivation a prodigious quantity of bacteria, which, being inoculated, readily produced the malady. —*Lancet.*

THE TERMINATION OF NERVES IN MUSCLE.

A MEMOIR on the interesting subject of the mode in which nerves terminate in muscle is contained in the part of the *Archives de Biologie* that has just been issued. It is from the pen of M. Foettinger, who has been engaged upon the subject for four years, and who has conducted his researches partly in the laboratory of M. Edouard v. Beneden in Liége, and partly in that of M. Engelmann in Utrecht. The muscles of insects were selected in preference to those of other animals, since the details of their structure are more easily recognizable under the microscope than those of other groups of the animal kingdom. The best preparations were obtained from the *Chrysomela cærulea*, a beetle which is common on various labiate plants, especially on the mints, from *Hydrophilus piceus*, *Lina tremula*, and the *Pusullus glaberrimus*. The animals were placed in strong alcohol for some days, and the isolated fibers of the legs or trunk examined with various powers. Each fiber or primitive fasciculus presents several nerve endings. In *Chrysomela* nine were sometimes found in the length of one millimeter, though this was an unusual number. In *Pusullus* as many as five were found in one millimeter and a half, and in *Hydrophilus* six were found in one fiber. There seems to be no very definite rule either as to the part of the muscular fiber on which they are placed, or as to the number of muscle elements intervening between two of them. Sometimes their position is linear; at others they appear to be placed on opposite sides of the muscular fiber, while taking five of them successively it was found that the number of muscular elements between the nerve endings was 23, 13, 21, and 14. These are usually conical in form, a nerve running to the summit of each cone. The cone itself is composed of granular matter, with nuclei interspersed through it, and it sometimes appears as if the granular matter was obscurely segmented into portions surrounding each nucleus.

The nerve endings or terminal plaques, as M. Foettinger calls them, are situated on the surface of the fiber, and their free surface is covered with a thin, structureless, transparent membrane, continuous with the sarcolemma of the muscular fiber on the one hand, and with the sheath of Schwann investing the nerve fiber on the other. The drawings which accompany the memoir exhibit the plaques as simply applied to the muscular fiber, no processes or fibrillæ penetrating it.

He has noticed the interesting fact, which, however, had been previously noted by Arndt and Fredericq, that in insects at least, contraction always begins in the muscular fiber at the plane of the cones, and at these points exclusively, and this fact may be shown to have an important bearing on the subject of *vis insita* of muscle. For since in microscopical specimens the transverse markings of the muscle are always found much more closely approximated just beneath the nerve-ending than elsewhere, it is reasonable to suppose that if a nerve-paralyzing agent like curara were administered to the animal, and if the effect of his agent were really, as is usually admitted, on the intramuscular portion of the nerve, the transverse markings should not present the approximation in question beneath the cone alone, but at any part of the contracted fiber indiscriminately. Unfortunately insects cannot be rendered motionless by curara. The point may perhaps be worked out with better success with the muscles of mammals.—*Lancet.*

CASTRATION FOR HYSTERIA.

UNDER the above title a French journal gives an account of a case which was presented to the Berlin Medical Society some months ago, and which has scarcely attracted the attention in this country which its significance deserves. Dr. Israel presented to the society a young woman twenty-three years old, cured of severe hysteria by "Battey's operation," of which she bore the cicatrix. The patient had suffered for some years from obstinate vomiting, accompanied by severe ovarian pains. She became extremely weak and anæmic. Many surgeons advised the operation, and she gradually arrived at the conviction that castration was the only remedy for her sad state. The operation was performed under chloroform "with all antiseptic precautions." During the first three days after the operation there was extreme tenderness in the lower part of the abdomen, and the ice was obliged to be constantly applied. At the same time there was retention of urine, which only passed off at the end of twelve days. A week after the operation the vomiting had ceased, and the pain in the ovarian region had disappeared. The patient's cure remained permanent. One detail, however, of this beautiful illustration of the value of "oöphorectomy" remains to be mentioned, and it is not unimportant. The operation was a pretended one. A superficial wound only was made! The result certainly justified the means.

A NEW VINE.

A FRENCH explorer, M. Lecart, who is at present on the banks of the Niger, writes home from "Koundian (Gangaran), July 25," that he has discovered a new vine, which promises to be of great economical value. He says the fruit of the vine is excellent and abundant in its cultivation very easy, its roots tuberose and perennial, while its branches are annual. It can be cultivated as easily as the dahlia. He himself had been eating the large grapes of the vine for eight days, and found them excellent, and he suggests that its culture ought to be attempted in all vine-growing countries as a possible remedy against the phylloxera. He is sending home seeds for experiment, both in France and Algeria, and will bring home specimens of the plant at all stages. It was not without danger that M. Lecart has been able to make this discovery, as he states that the people of the Soudan are in a state of great excitement and apprehension at the many attempts of white people to penetrate into their country. The story of the last expedition sent by France into the south of Algeria has spread to all parts, and the conviction of the natives is that the travelers are collecting information preparatory to conquest. Perhaps the natives are not very far wrong.

A CATALOGUE, containing brief notices of many important scientific papers heretofore published in the SUPPLEMENT, may be had gratis at this office.

THE

Scientific American Supplement.

PUBLISHED WEEKLY.

Terms of Subscription, $5 a Year.

Sent by mail, postage prepaid, to subscribers in any part of the United States or Canada. Six dollars a year, sent, prepaid, to any foreign country.

All the back numbers of THE SUPPLEMENT, from the commencement, January 1, 1876, can be had. Price, 10 cents each.

All the back volumes of THE SUPPLEMENT can likewise be supplied. Two volumes are issued yearly. Price of each volume, $2.50, stitched in paper, or $3.50, bound in stiff covers.

COMBINED RATES.—One copy of SCIENTIFIC AMERICAN and one copy of SCIENTIFIC AMERICAN SUPPLEMENT, one year, postpaid, $7.00.

A liberal discount to booksellers, news agents, and canvassers.

MUNN & CO., Publishers,
37 Park Row, New York, N. Y.

TABLE OF CONTENTS.

PAGE

I. ENGINEERING AND MECHANICS.—Military Steam Electric Machine and Light. 2 figures. Sautter and Lemonnier's combination 4055
The Royal Arsenal at Woolwich.—Nine mile guns.—Carriage department.—Forge and factory.—The Control department..... 4056
Trial of a Compressed Air Locomotive.—Beaumont's engine..... 4057
The Polyphemus.—3 figures.—The New British torpedo boat, Polyphemus..... 4057

II. TECHNOLOGY AND CHEMISTRY.—Mr. James Nasmyth, C.E., on Free Hand Drawing 4057
Chrome Leather 4057
Direct Positive Transparencies 4057
Methods of Obtaining Positives in the Camera. By F. JAHNS... 4059
Chlorozone: A Substitute for Chloride of Lime in Bleaching... 4062
Detection of Inks. By W. THOMSON, F.R.S.E..... 4062
An Economical Process for Treating Minerals and other Substances Containing Small Quantities of Phosphate of Lime.—By C. H. ALLDRED, F.C.S..... 4062
On the Liquefaction of Ozone and on its Color in the Gaseous State. By MM. P. HAUTEFEUILLE and J. CHAPPUIS..... 4062
Freezing Mixtures Formed by an Acid and a Hydrated Salt. By BERTHELOT 4063
On Ostrich Feather Dyeing. By PAUL ALEX..... 4063
Fast Red on Cotton with Artificial Alizarine. By M. MOYRET... 4063
Chemical Cause of the Poisonous Nature of Arsenic..... 4063
Certain Properties of Flames. By M. MEYRENEUF..... 4063
A New Process for Producing Malleable Nickel of Different Degrees of Hardness. By J. GARNIER..... 4063
A Method of Determining the Topography of Chemical Processes in the Animal System. By W. KOCHS..... 4063
Alcohol in Animal Tissues. By J. BECHAMP..... 4063

III. MEDICINE AND SURGERY.—A Great Medical Discovery. By INVESTIGATUS DISCOVERANDUM, M.D., C—A, 10 A. C..... 4067
Copper as a Preservative against Cholera and Typhoid Fever 4067
Headache as a Symptom of Uræmia 4067
On Some Points in the Management of Asthenopic Symptoms in Emmetropic and Ametropic Eyes. By O. D. HOMEROY, M.D. Lecture I. Treatment of asthenopic symptoms with spectacles.—The same without spectacles.—The use of atropine.—General hygienic management of asthenopia in emmetropic eyes.—Dyer's plan.—Indications for the use of glasses in presbyopia.—The use of glasses in an aphakial eye. Lecture II. Hypermetropia.—Treatment.—Convergent squint.—Glasses after tenotomy.—Atropine in convergent squint in the hypermetropic eye.—Vision of hypermetropes.—Astigmatism in hypermetropia.—Myopia.—What glasses should be given to a myope, etc., etc..... 4068
Anthrax..... 4070
The Termination of Nerves in Muscle..... 4070

IV. ELECTRICITY, LIGHT, ETC.—Sir William Thomson's Siphon Recorder for Submarine Telegraphy. 3 figures. Siphon recorder.—Diagram showing arrangement of submarine cable.—Message transmitted by siphon recorder.—Siphon recorder alphabet..... 4060
Apparatus for the Detection of Fire Damp in Mines. 4 figures... 4060
The Phenomena of Fluorescence. By E. H. HODGES..... 4061

V. NATURAL HISTORY, ETC.—Peculiar Insects. Protective resemblances to leaves in grasshoppers and butterflies. 3 figures. Brazilian grasshoppers (natural size). Indian butterflies in flight and at rest 4065
Salmon Disease..... 4066

VI. ART, ARCHITECTURE, ETC.—Roman Villa in the Isle of Wight. Half page illustration 4058
Sir Josiah Mason's Science College, Birmingham, England. Half page illustration 4058
Settee, Easy Chair, and Small Chair. Design of H. Duhring, by Dubell, Vienna. Large illustration..... 4059
St. Mark's Library, Venice 4060
Roof Covering..... 4060

VII. GEOLOGY.—Igneous Rocks. Address to the Geological Section of the British Association, 1880. By H. CLIFTON SORBY. The microscopic study of rocks.—Crystalline blow-pipe beads.—Artificial slags.—Rocks artificially melted.—Volcanic rocks.—Granitic rocks.—General results.—Conclusions..... 4063

VIII. MISCELLANEOUS.—Albert J. Myer. The meteorological services of the late Chief Signal Officer, U. S. A 4066
Dwarfs and Giants. 1 illustration. The Chinese Giant Chang, and the Dwarf Che-Mah, at the London Aquarium..... 4066
Woman as a Sanitary Reformer..... 4066

IX. AGRICULTURE.—A New Vine..... 4070

PATENTS.

In connection with the **Scientific American,** Messrs. MUNN & Co. are Solicitors of American and Foreign Patents, have had 35 years' experience, and now have the largest establishment in the world. Patents are obtained on the best terms.

A special notice is made in the **Scientific American** of all Inventions patented through this Agency, with the name and residence of the Patentee. By the immense circulation thus given, public attention is directed to the merits of the new patent, and sales or introduction often easily effected.

Any person who has made a new discovery or invention can ascertain, free of charge, whether a patent can probably be obtained, by writing to MUNN & Co.

We also send free our Hand Book about the Patent Laws, Patents, Caveats, Trade Marks, their costs, and how procured, with hints for procuring advances on inventions. Address

MUNN & CO., 37 Park Row, New York.
Branch Office, cor. F and 7th Sts., Washington, D. C.